ATE5 Chapter 112 Suspension System Principles & Components

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This 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 learning objectives to students as listed BELOW: 1. Explain the different types of frame construction and the platforms of a vehicle. 2. List various types of suspensions and their component parts. 3. Explain how coil, leaf, and torsion bar springs work. 4. Describe how suspension components function to allow wheel movement up and down, and provide for turning. 5. Describe how shock absorbers control spring forces.
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 112: ATE5 Chapter Images

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1. SLIDE 1 CH112 SUSPENSION SYSTEM PRINCIPLES & COMPONENTS

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

Videos

Suspension Components (View) (Download)

2. **SLIDE 2 EXPLAIN Figure 112-1** A typical truck frame is an excellent example of a ladder-type frame. The two side members are connected by a crossmember.
3. **SLIDE 3 EXPLAIN Figure 112-2** Rubber cushions used in body or frame construction isolate noise and vibration from traveling to the passenger compartment.
4. **SLIDE 4 EXPLAIN Figure 112-3 (a)** Separate body and frame construction;
5. **SLIDE 5 EXPLAIN Figure 112-3 (b)** Unitized construction: the small frame members are for support of the engine and suspension components. Many vehicles attach the suspension components directly to the reinforced sections of the body and do not require the rear frame section.
6. **SLIDE 6 EXPLAIN Figure 112-4** Welded metal sections create a platform that combines the body with the frame using unit-body construction.

DISCUSSION: Ask students to discuss differences between truck and car suspension systems. Ask the students to discuss why only some pickup trucks are constructed with ladder type frames

QUESTION

DISCUSSION: Ask the students to discuss why manufacturers like to use unitized construction.

QUESTION

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DISCUSSION: Ask the students to discuss what they believe is the best type of frame construction.

DEMONSTRATION: Show the underside of vehicles with unitized and frame construction. Point out differences

HANDS-ON TASK: Have the students identify vehicles with unitized & frame construction.

DISCUSSION: Ask the students to discuss why manufacturers use the platform system. Why don't OEMs use common platforms for their vehicles.

HANDS-ON TASK: Have the students identify both independent and solid axle rear suspensions.

DISCUSSION: Ask the students to discuss how to determine when a spring needs to be replaced. Ask the students to discuss why heating a spring to lower a vehicle is a bad idea.

7. **SLIDE 7 EXPLAIN Figure 112-5** Solid I-beam axle with leaf springs.
8. **SLIDE 8 EXPLAIN Figure 112-6** When one wheel hits a bump or drops into a hole, both left and right wheels are moved. Because both wheels are affected, the ride is often harsh and feels stiff.
9. **SLIDE 9 EXPLAIN Figure 112-7** A typical independent front suspension used on a rear-wheel-drive vehicle. Each wheel can hit a bump or hole in the road independently without affecting the opposite wheel

DISCUSSION: Discuss why non-independent suspension work better in a truck than would an independent suspension system.

10. **SLIDE 10 EXPLAIN Figure 112-8** spring was depressed 4 inches due to a weight of 2,000 Ib. This means that this spring has a spring rate (K) of 500 Ib per inch (2000 ÷ 4 in. = 500 Ib./in.).

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11. **SLIDE 11 EXPLAIN Figure 112-9** The spring rate of a coil spring is determined by the diameter of the spring and the diameter of the steel used in its construction plus the number of coils and the free length (height).
12. **SLIDE 12 EXPLAIN Figure 112-10** Coil spring ends are shaped to fit the needs of a variety of suspension designs.
13. **SLIDE 13 EXPLAIN Figure 112-11** A constant-rate spring compresses at the same rate regardless of the amount of weight that is applied.
14. **SLIDE 14 EXPLAIN Figure 112-12** Variable-rate springs come in a variety of shapes and compress more slowly as weight is applied.
15. **SLIDE 15 EXPLAIN Figure 112-13** Two springs, each with a different spring rate and length, can provide the same ride height even though the higher-rate spring will give a stiffer ride.

DEMONSTRATION: Show examples of coil spring ends.

16. **SLIDE 16 EXPLAIN Figure 112-14** Stiffer springs bounce at a higher frequency than softer springs.
17. **SLIDE 17 EXPLAIN Figure 112-15** The wheel and arm act as a lever to compress the spring. The spring used on the top picture must be stiffer than the spring used on the strut-type suspension shown on the bottom because the length of the lever arm is shorter.
18. **SLIDE 18 EXPLAIN Figure 112-16** spring cushion helps isolate noise and vibration from being transferred to the passenger compartment

DEMONSTRATION: Show examples of replacement coil springs.

DISCUSSION: Ask the students to discuss tools they could use to compress a spring.

19. **SLIDE 19 EXPLAIN Figure 112-17** This replacement coil spring is coated to prevent rust and corrosion and colored to help identify the spring and/or spring manufacturer.

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20. **SLIDE 20 EXPLAIN Figure 112-18** A typical leaf spring used on the rear of a pickup truck showing the plastic insulator between the leaves, which allows the spring to move without creating wear or noise.
21. **SLIDE 21 EXPLAIN Figure 112-19** A typical leaf spring installation. The longest leaf, called the main leaf, attaches to the frame through a shackle and a hanger.
22. **SLIDE 22 EXPLAIN Figure 112-20** All multileaf springs use a center bolt to not only hold the leaves together but also help retain the leaf spring in the center of the spring perch.
23. **SLIDE 23 EXPLAIN Figure 112-21** When a leaf spring is compressed, the spring flattens and becomes longer. The shackles allow for this lengthening. Rubber bushings are used in the ends of the spring and shackles to help isolate road noise from traveling into the passenger compartment.
24. **SLIDE 24 EXPLAIN Figure 112-22** Typical rear leaf-spring suspension of a rear-wheel-drive vehicle.
25. **SLIDE 25 EXPLAIN Figure 112-23** As the vehicle is loaded, the leaf spring contacts a section of the frame. This shortens the effective length of the spring, which makes it stiffer.
26. **SLIDE 26 EXPLAIN Figure 112-24** Many pickup trucks, vans, and sport utility vehicles (SUVs) use auxiliary leaf springs that contact the other leaves when the load is increased.

DEMONSTRATION: Show examples of center bolts, shackles, and rebound clips.

27. **SLIDE 27 EXPLAIN Figure 112-25 (a)** A fiberglass spring is composed of long fibers locked together in an epoxy (resin) matrix.
28. **SLIDE 28 EXPLAIN Figure 112-25 (b)** When the spring compresses, the bottom of the spring expands and the top compresses. Composite leaf springs are used and mounted transversely (side-to-side) on Chevrolet Corvettes and at rear on some other GM vehicles.

DEMONSTRATION: Show examples of steel leaf springs and composite leaf springs

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DISCUSSION: Ask the students to discuss why adding heavy-duty springs will not increase the gross vehicle weight rating

HANDS-ON TASK: Have the students label parts of a leaf spring and leaf spring suspension. Have students use sticky notes or a similar product

DISCUSSION: Ask students to discuss what is affected when center bolt moves in spring perch.

29. **SLIDE 29 EXPLAIN Figure 112-26** A torsion bar resists twisting and is used as a spring on some cars and many four-wheel-drive pickup trucks and sport utility vehicles. The larger the diameter, or the shorter the torsion bar, the stiffer the bar. A torsion bar twists very little during normal operation and about a 1/16 of a revolution during a major suspension travel event.
30. **SLIDE 30 EXPLAIN Figure 112-27** Longitudinal torsion bars attach at the lower control arm at the front and at the frame at the rear of the bar.
31. **SLIDE 31 EXPLAIN Figure 112-28** One end of the torsion bar attaches to the lower control arm and the other to an anchor arm that is adjustable.

DEMONSTRATION: Show examples of torsion bars

DISCUSSION: Ask the students to discuss why not all manufacturers of SUVs include torsion-bar suspensions as standard equipment.

DISCUSSION: Ask the students to discuss any warning signs that would occur before a torsion bar breaks.

32. **SLIDE 32 EXPLAIN Figure 112-29** spindle supports the wheels and attaches to the control arm with ball-and-socket joints called ball joints. The control arm attaches to the frame of the vehicle through rubber bushings to help isolate noise and vibration between road and body
33. **SLIDE 33 EXPLAIN Figure 112-30** strut rods provide longitudinal support to the suspension to prevent forward or rearward movement of control arms.

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DEMONSTRATION: Show examples of upper control arms, lower control arms, and spindles.

34. **SLIDE 34 EXPLAIN Figure 112-31** The steering knuckle used on a short/long-arm front suspension.
35. **SLIDE 35 EXPLAIN Figure 112-32** A kingpin is a steel shaft or pin that joins the steering knuckle to the suspension and allows the steering knuckle to pivot.
36. **SLIDE 36 EXPLAIN Figure 112-33** Control arms are used to connect the steering knuckle to the frame or body of the vehicle and provide the structural support for the suspension system.

DISCUSSION: Ask the students to discuss whether suspension systems should be 100% anti-squat or anti-dive

37. **SLIDE 37 EXPLAIN Figure 112-34** Ball joints provide the freedom of movement necessary for steering and suspension movements.
38. **SLIDE 38 EXPLAIN Figure 112-35** The upper ball joint is load carrying in this type of suspension because the weight of the vehicle is applied through the spring, upper control arm, and ball joint to the wheel. The lower control arm is a lateral link, and the lower ball joint is called a follower ball joint.
39. **SLIDE 39 EXPLAIN Figure 112-36** The lower ball joint is load carrying in this type of suspension because the weight of the vehicle is applied through the spring, lower control arm, and ball joint to the wheel.

DISCUSSION: Ask the students to discuss the advantages of load-carrying ball joints.

40. **SLIDE 40 EXPLAIN Figure 112-37** All ball joints, whether tension or compression loaded, have a bearing surface between the ball stud and socket.

DEMONSTRATION: Show examples of tension loaded & compression-loaded ball joints.
Figure 112–37

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DISCUSSION: **Ask the students to discuss whether compression-loaded ball joints or tension loaded ball joints are better.**

Unlock the steering wheel before working on ball joints. This provides easier access to the ball joints.

41. **SLIDE 41 EXPLAIN Figure 112-38** strut rod is the longitudinal support to prevent front-to-back wheel movement. Struts rods are only used when there is only ***one lower control arm bushing*** and not used where there are two lower control arm bushings.
42. **SLIDE 42 EXPLAIN Figure 112-39** Strut rod bushings insulate steel bar from vehicle frame or body.

DEMONSTRATION: **Show examples of strut rod bushings**

HANDS-ON TASK: **Have the students remove and inspect strut rod bushings.**

Don’t use petroleum or mineral-based lubricants on stabilizer bar bushings. Lubricants cause bushings to deteriorate.

43. **SLIDE 43 EXPLAIN Figure 112-40** Typical stabilizer bar installation.
44. **SLIDE 44 EXPLAIN Figure 112-41** As the body of the vehicle leans, the stabilizer bar is twisted. The force exerted by the stabilizer bar counteracts the body lean.
45. **SLIDE 45 EXPLAIN Figure 112-42** Stabilizer bar links are sold as a kit consisting of the long bolt with steel sleeve and rubber or urethane bushings. Steel washers are used on both sides of the rubber bushings as shown.
46. **SLIDE 46 EXPLAIN Figure 112-43** Notice how the lower control arm pulls down on the mounting bushing when the vehicle is hoisted off the ground, allowing the front suspension to drop down. These bushings are a common source of noise, especially when cold. Lubricating the bushings with paste silicone grease often cures the noise.

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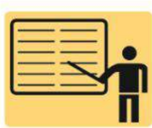
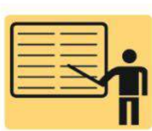
47. **SLIDE 47 EXPLAIN Figure 112-44** (a) Movement of vehicle supported by springs without dampening device.
48. **SLIDE 48 EXPLAIN Figure 112-44** (b) Spring action is dampened with a shock absorber.
49. **SLIDE 49 EXPLAIN Figure 112-44** (c) The function of any shock absorber is to dampen the movement or action of a spring, similar to using a liquid to control the movement of a weight on a spring
50. **SLIDE 50 EXPLAIN Figure 112-44** (d) similar to using liquid to control movement of a weight on a spring.
51. **SLIDE 51 EXPLAIN Figure 112-45** Shock absorbers work best when mounted as close to the spring as possible. Shock absorbers that are mounted straight up and down offer the most dampening.
52. **SLIDE 52 EXPLAIN Figure 112-46** When a vehicle hits a bump in the road, suspension moves upward. This is called compression or jounce. Rebound is when spring (coil, torsion bar, or leaf) returns to its original position.

DEMONSTRATION: Show examples of hydraulic shock absorbers and examples of gas charged shock absorbers



53. **SLIDE 53 EXPLAIN Figure 112-47 (a)** A cutaway drawing of a typical double-tube shock absorber.
54. **SLIDE 54 EXPLAIN Figure 112-47 (b)** Notice the position of the intake and compression valve during rebound (extension) and compression.
55. **SLIDE 55 EXPLAIN Figure 112-48** Oil flow through a deflected disc-type piston valve. The deflecting disc can react rapidly to suspension movement. For example, if a large bump is hit at high speed, the disc can deflect completely and allow the suspension to reach its maximum jounce distance while maintaining a controlled rate of movement.



56. **SLIDE 56 EXPLAIN Figure 112-49** Gas-charged shock absorbers are manufactured with a double-tube design similar to conventional shock absorbers and with a single or monotube design.
57. **SLIDE 57 EXPLAIN Figure 112-50** The shock absorber is on the right and the fluid reservoir for the shock is on the left

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58. **SLIDE 58 EXPLAIN Figure 112-51** A rubber tube forms an inflatable air chamber at the top of an air shock. The higher the air pressure in the chamber, the stiffer the shock.
59. **SLIDE 59 EXPLAIN Figure 112-52 (a)** The front suspension of a Lincoln with an air-spring suspension.
60. **SLIDE 60 EXPLAIN Figure 112-52 (b)** Always check in the trunk for the cutoff switch for a vehicle equipped with an air suspension before hoisting or towing the vehicle.
61. **SLIDE 61 EXPLAIN Figure 112-53** Some air springs are auxiliary units to coil spring and are used to control ride height while coil spring is weight-bearing unit.
62. **SLIDE 62 EXPLAIN Figure 112-54** A coil-over shock is a standard hydraulic shock absorber with a coil spring wrapped around it to increase stiffness and/or take some of the carrying weight off of the springs.

DISCUSSION: Ask the students to discuss gases other than nitrogen that are used in gas-charged shock absorbers.

DEMONSTRATION: Show examples of air inflatable shock absorbers & Coil-Over shocks

DISCUSSION: Ask the students to discuss why SHOCK rebound and jounce valve design would need to be different.

63. **SLIDE 63 EXPLAIN Figure 112-55** A strut is a structural part of the suspension and includes the spring and shock absorber in one assembly.
64. **SLIDE 64 EXPLAIN Figure 112-56** A modified strut used on the rear suspension; it is part of the structural part of the assembly.

In adverse weather conditions, fasteners may become difficult to remove. Make sure to use sufficient penetrating oil & allow enough time for oil to soak in & work.

DISCUSSION: Ask the students to discuss why SOME manufacturers use modified struts instead of MacPherson struts.

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	65. **SLIDE 65 EXPLAIN Figure 112-57** Suspension bumpers are used on all suspension systems to prevent metal-to-metal contact between the suspension and the frame or body of the vehicle when the suspension “bottoms out” over large bumps or dips in the road.
	DISCUSSION: Ask the students to discuss how condition of the bump stops can be an indicator of other suspension problems.
	HANDS-ON TASK: Have the students inspect the condition of the bump stops on a LAB vehicle.
	ON-VEHICLE NATEF TASK: Research applicable vehicle and service information. Page 340
	SEARCH INTERNET: Have the students search Internet for other vehicles that share the same platform as their own vehicle. Or have the students draw the name of a vehicle “out of a hat.” **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**