JAMES D. HALDERMAN

FIFTH EDITION

AUTOMOTIVE CHASSIS SYSTEMS

CHAPTER 26

Rear Suspension and Service

PEARSON

PEARSON AUTOMOTIVE

OBJECTIVES

After studying Chapter 26, the reader will be able to:

1. Prepare for ASE Suspension and Steering (A4) certification test content area “B” (Suspension System Diagnosis and Repair).
2. Describe the various types and styles of rear suspension.
3. Explain the differences among the different types of rear axles.
4. List the steps necessary to replace rear shock absorbers.
5. Explain how to replace rear leaf and coil springs.

KEY TERMS

- Axle windup
- Chapman strut
- Hotchkiss drive
- IRS
- Live axle
- Panhard rod
- Semi-independent suspension
- Semi-trailing arm
- Solid axle
- Torque arm
- Track rod
- Trailing arm
- Watts linkage

SOLID REAR AXLES

- A **solid axle** can be used at the rear of either a rear-wheel-drive or front-wheel-drive vehicle.
- On a rear-wheel-drive vehicle, a solid rear axle consists of the differential gears and axle shafts inside a solid housing.
- On a front-wheel-drive vehicle, a solid axle is usually a simple U-shaped or tubular beam that may contain a torsion bar, rod, or tube to allow some twisting action.

SOLID REAR AXLES

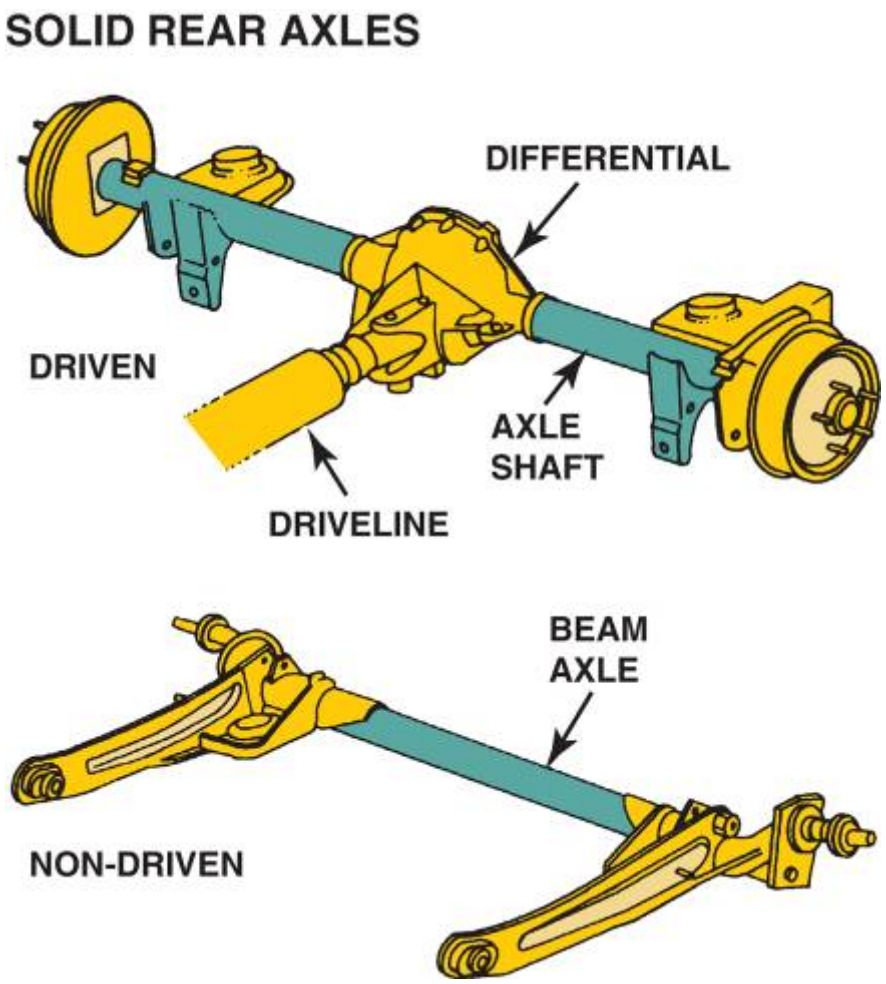

FIGURE 26–1 Solid axles are used on rear-wheel-drive vehicles as well as front-wheel-drive vehicles.

SOLID REAR AXLES

- Solid axles have some handling characteristics that are inferior to those of an independent suspension.
- Disadvantages of a solid axle include the following:
  - Increased proportion of unsprung weight
  - Side-to-side road shock transference
  - Poorer tire adhesion

SOLID REAR AXLES

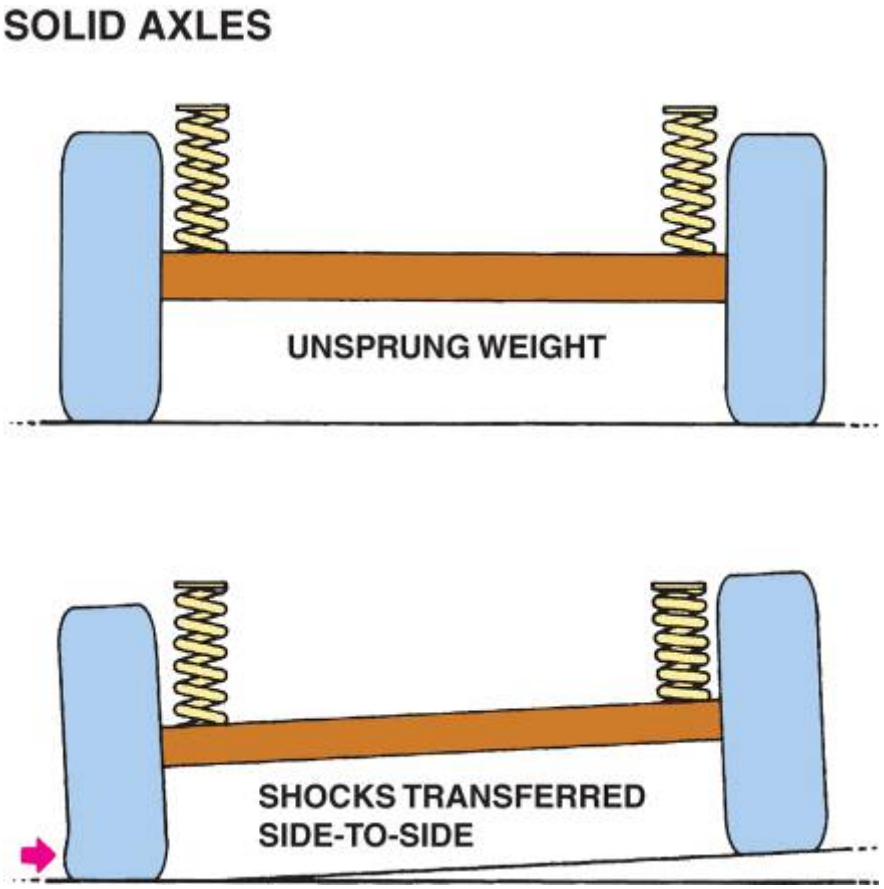

FIGURE 26–2 A solid axle supports the springs, so the axle and suspension components are unsprung weight. When one wheel rides over a bump, the force of impact transfers through the solid axle to the opposite side, leading to unstable handling.

What Is Axle Windup?

FREQUENTLY ASKED QUESTION

- **Axle windup** is a product of the law of physics, which states that every action produces an equal and opposite reaction. As the axle shafts rotate in one direction to drive the wheels, the axle housing attempts to rotate in the opposite direction. The force of this reaction tends to lift the front end of the vehicle during acceleration. Axle windup is a particular problem with a solid, driven rear axle because the axle housing concentrates the reacting force. Under extreme acceleration, the reacting force can actually tilt the drive shaft upward and lift the front wheels off the ground. Leaf springs, control arms, pinion snubbers, and torque arms all are means of controlling axle windup.

What Is Axle Windup?

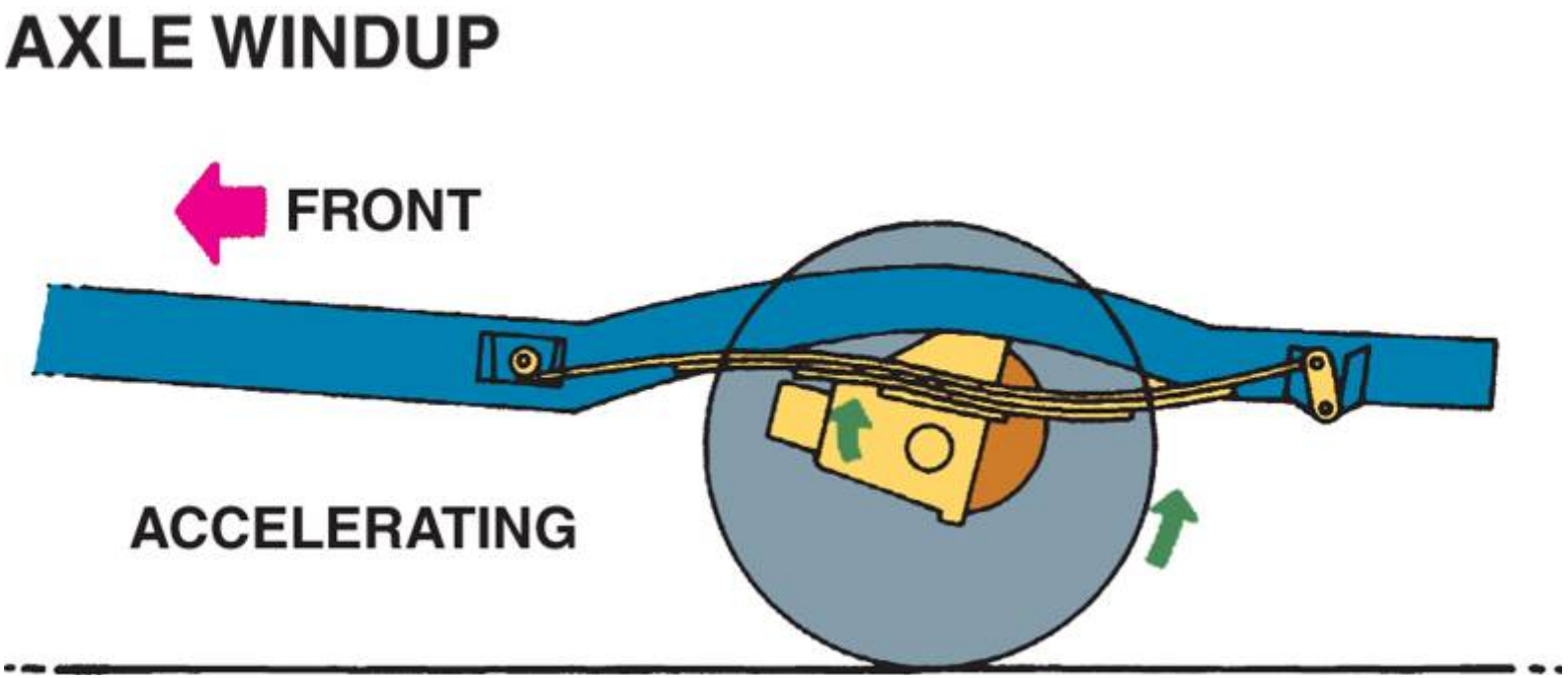

FIGURE 26–3 When the axle housing reacts against the force of axle shaft rotation, the front of the differential tilts upward, creating axle windup.

LEAF SPRING REAR SUSPENSIONS

- A leaf spring suspension is a simple system because it does not require control arms to brace and position the axle.
- The leaf springs link the axle to the frame and effectively serve two purposes:
  - Absorbing road shock
  - Locating the axle under the vehicle
- Most rear-wheel-drive trucks use a solid rear axle with leaf springs in an arrangement called a **Hotchkiss drive.**

LEAF SPRING REAR SUSPENSIONS

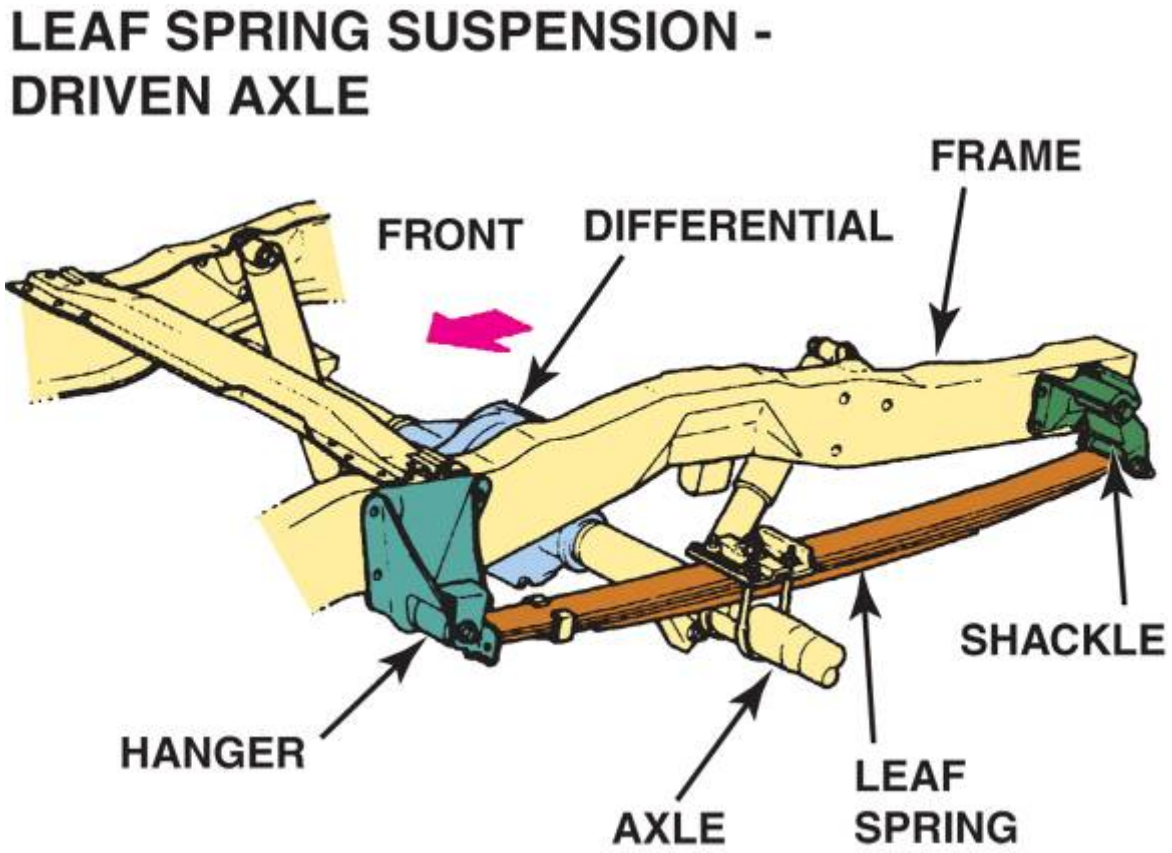

FIGURE 26–4 A typical rear-wheel-drive pickup truck rear suspension equipped with leaf springs. This type of arrangement is called a Hotchkiss drive and the drive train forces are controlled by the rear suspension components.

LEAF SPRING REAR SUSPENSIONS

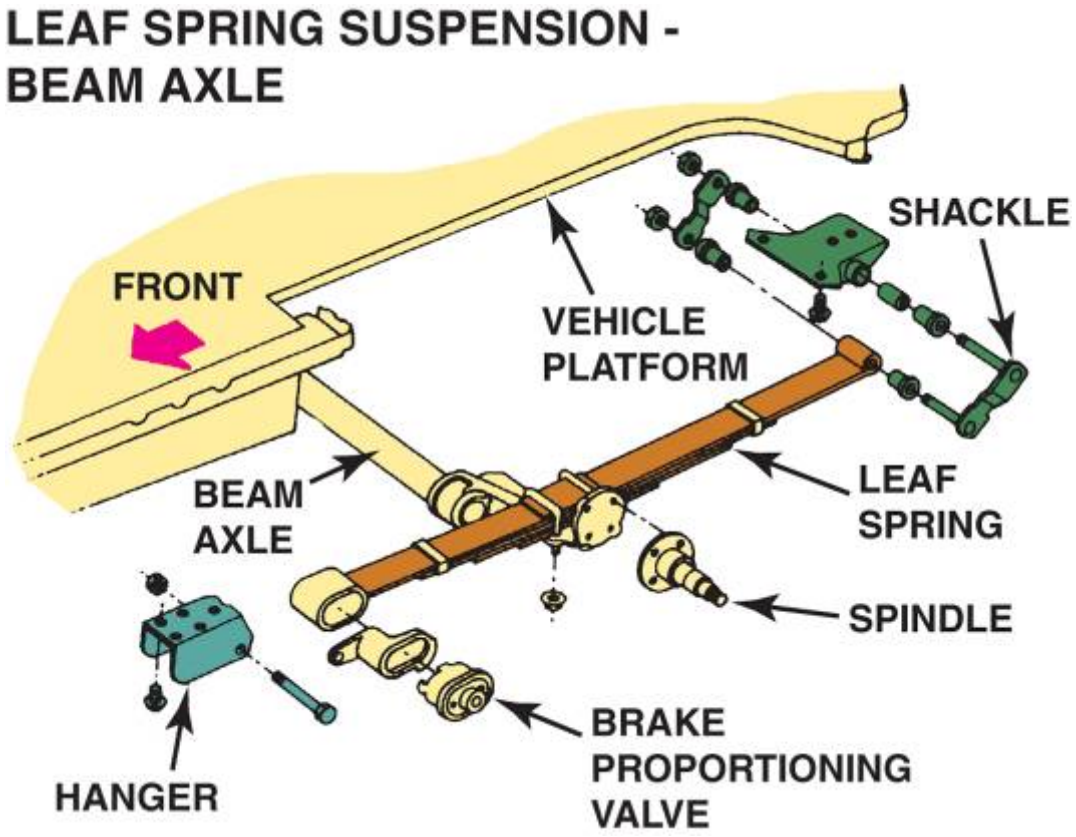

FIGURE 26–5 An exploded view of a beam axle with multi-leaf springs.

TRAILING ARM REAR SUSPENSIONS

- A **trailing arm** extends from a frame cross-member located ahead of the rear axle back to the axle housing or a wheel knuckle.
- Trailing arms run parallel to the centerline of the chassis.

FIGURE 26–6 A trailing arm rear suspension with a solid axle used on a front-wheel-drive vehicle.

TRAILING ARM REAR SUSPENSIONS

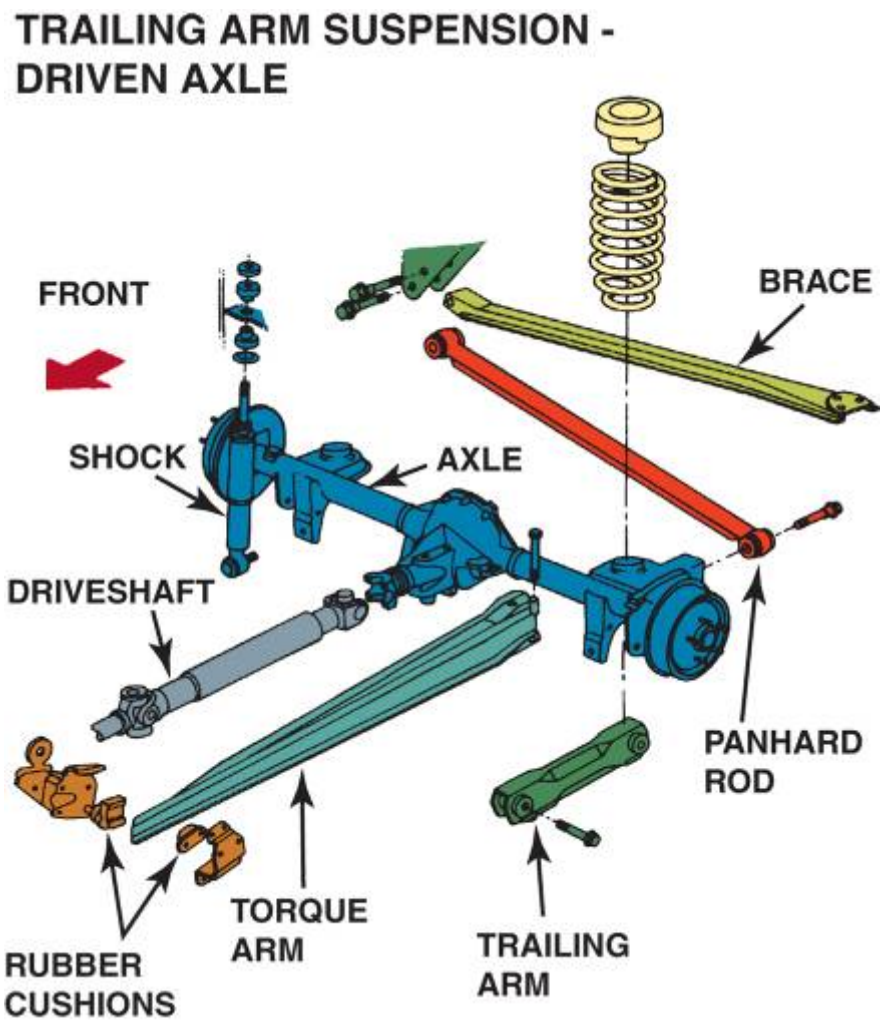

FIGURE 26–7 The Camaro and Firebird rear suspension systems use a torque arm to control axle windup. If the rubber torque arm bushings (cushions) are worn, a loud "bang" could be heard and felt when accelerating suddenly.

TRAILING ARM REAR SUSPENSIONS

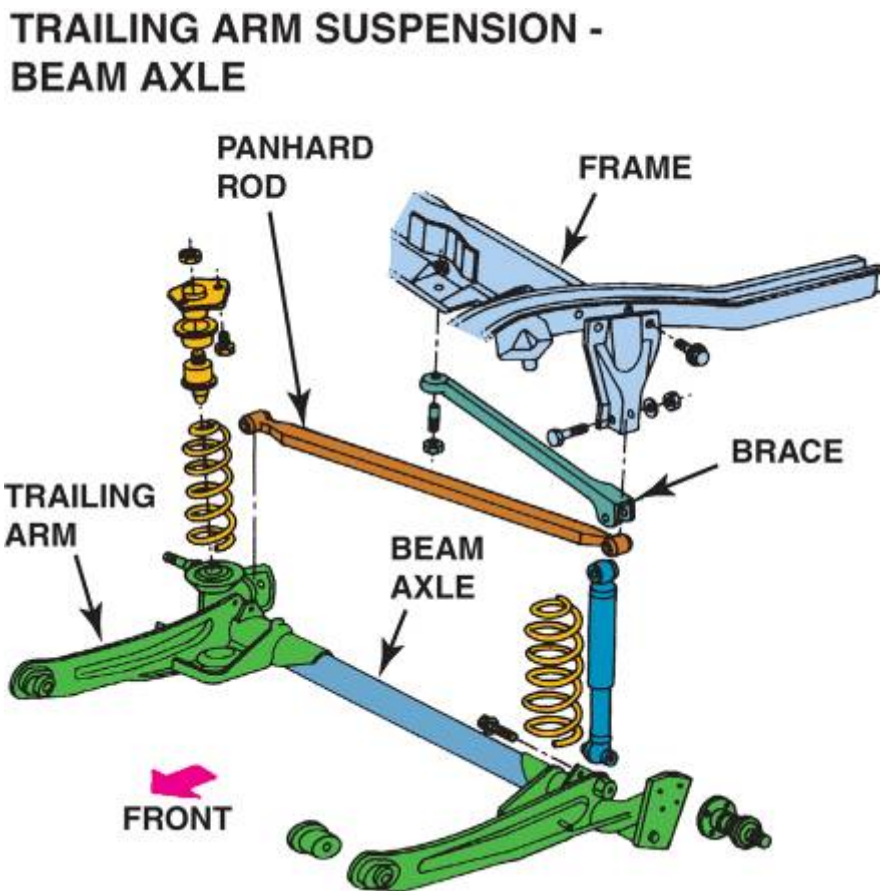

FIGURE 26–8 A typical beam axle rear suspension, which uses trailing arms and coil springs along with a track rod, also called a Panhard rod, to control side-to-side axle movement.

SEMI-TRAILING ARM REAR SUSPENSIONS

- A **semi-trailing arm** is similar to a trailing arm in that it extends back from a frame member to the axle.
  - However, a trailing arm is parallel to the vehicle centerline whereas a semi-trailing arm pivots at an angle to the vehicle centerline.
- Semi-trailing arms have an advantage over trailing arms because they control both side-to-side and front-to-rear motion.
- Typically, a semi-trailing arm suspension uses coil springs, air springs, or pivot-base struts.

SEMI-TRAILING ARM REAR SUSPENSIONS

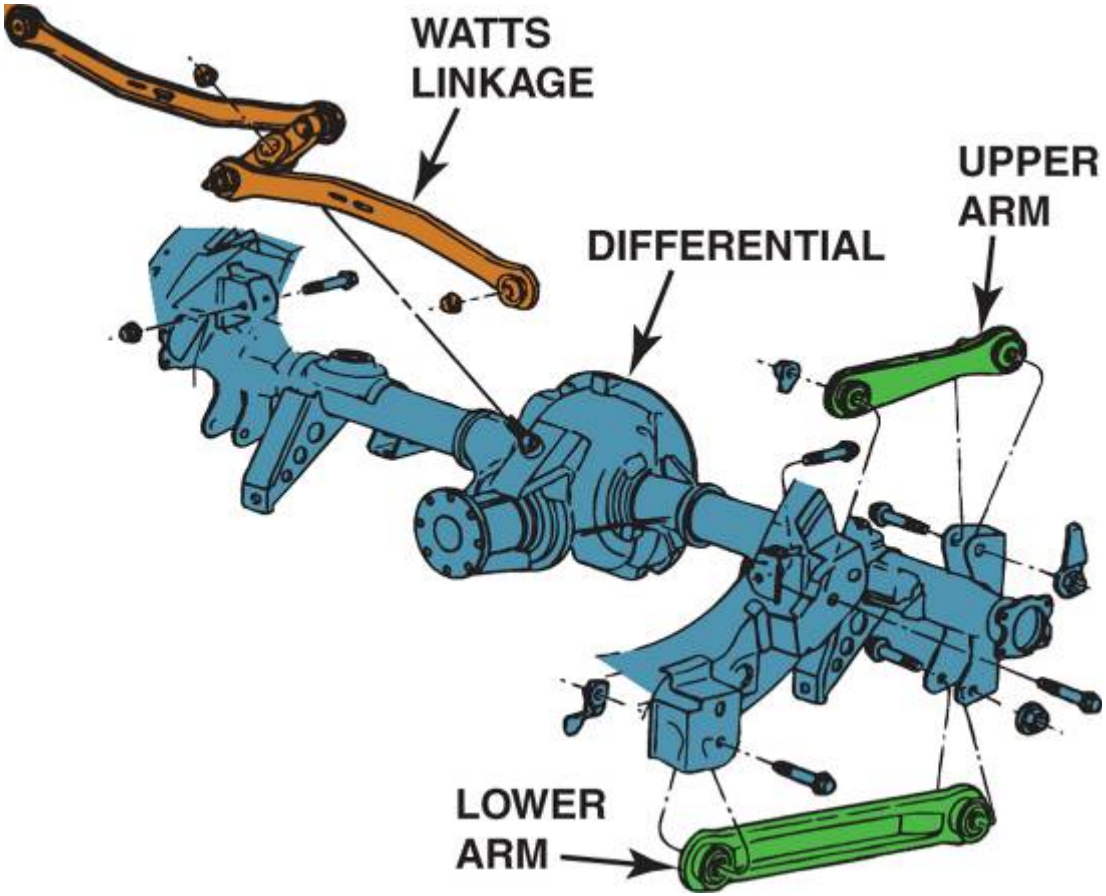

FIGURE 26–9 This Ford rear suspension uses upper and lower semi-trailing arms to mount the rear axle and a watts linkage to control side-to-side movement.

INDEPENDENT REAR SUSPENSIONS

- The use of **independent rear suspension,** called **IRS,** has grown dramatically over the past several decades to the point where such systems are now fairly common, especially on front-wheel-drive vehicles and some rear-wheel-drive vehicles.
- Although rarely used on trucks, a number of rear-wheel-drive vehicles do feature an independent rear suspension.

INDEPENDENT REAR SUSPENSIONS

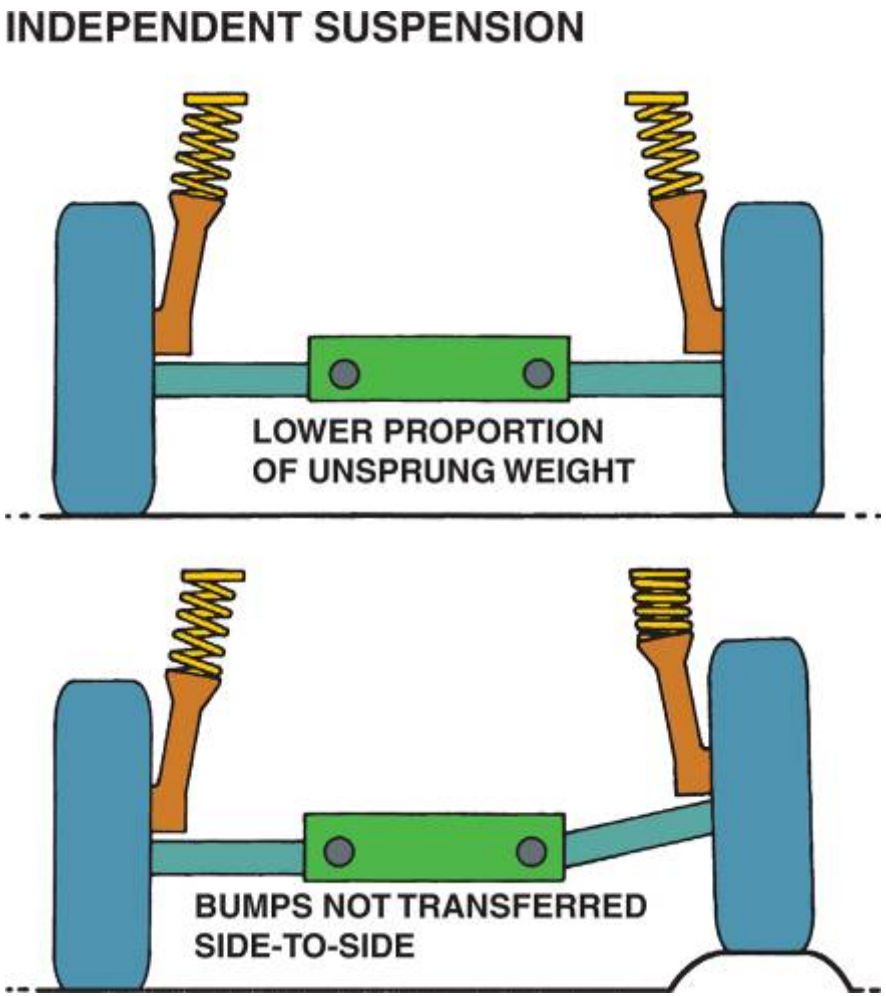

FIGURE 26–10 An independent rear suspension provides a better ride because less weight is unsprung and the suspension is able to react quickly to bumps in the road without affecting the opposite side.

INDEPENDENT REAR SUSPENSIONS

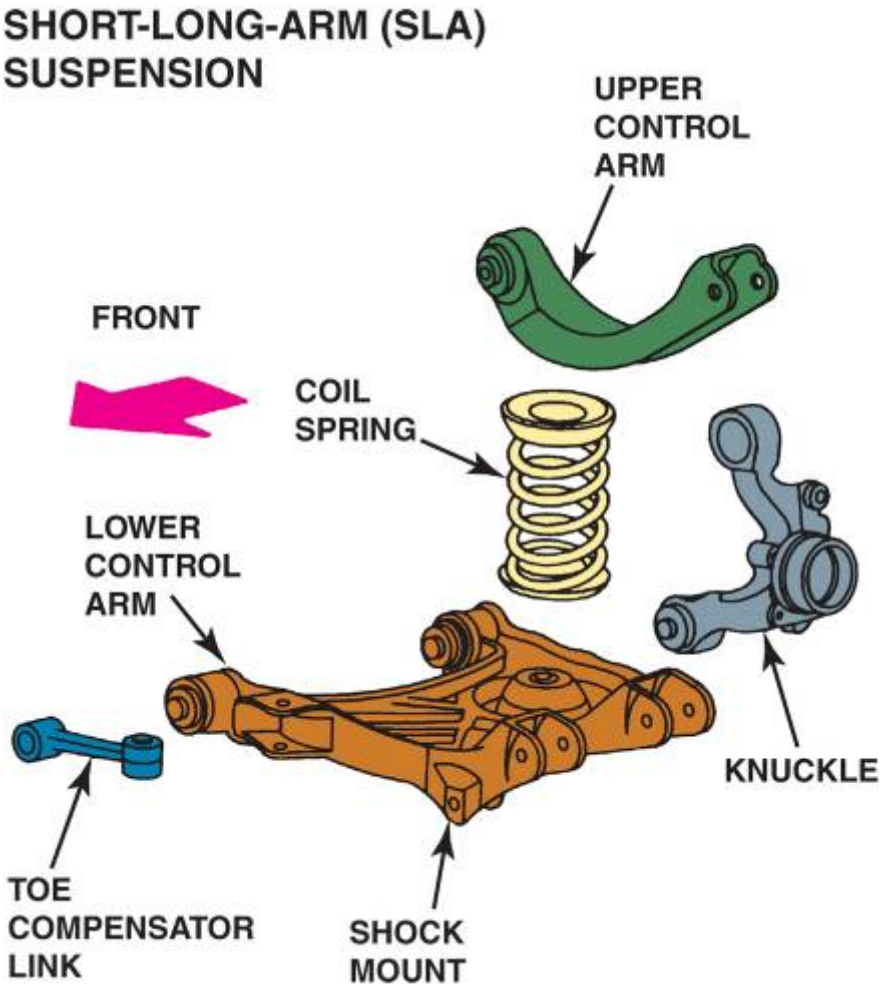

FIGURE 26–11 A typical short/long-arm independent rear suspension.

INDEPENDENT REAR SUSPENSIONS

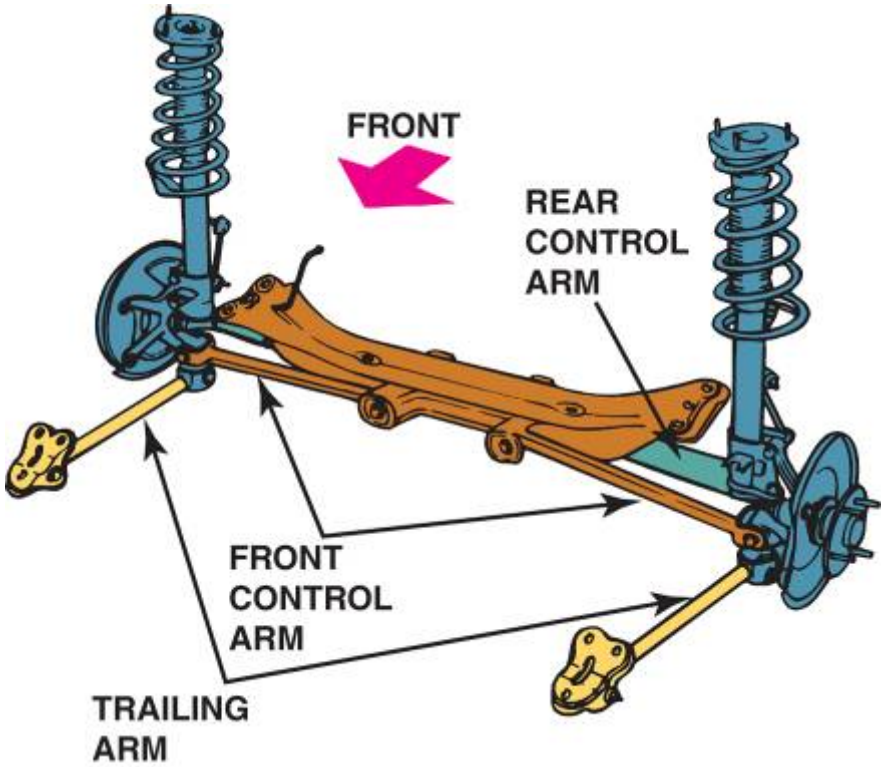

FIGURE 26–12 This independent rear suspension uses a MacPherson strut, two parallel lower transverse control arms, and a trailing arm.

INDEPENDENT REAR SUSPENSIONS

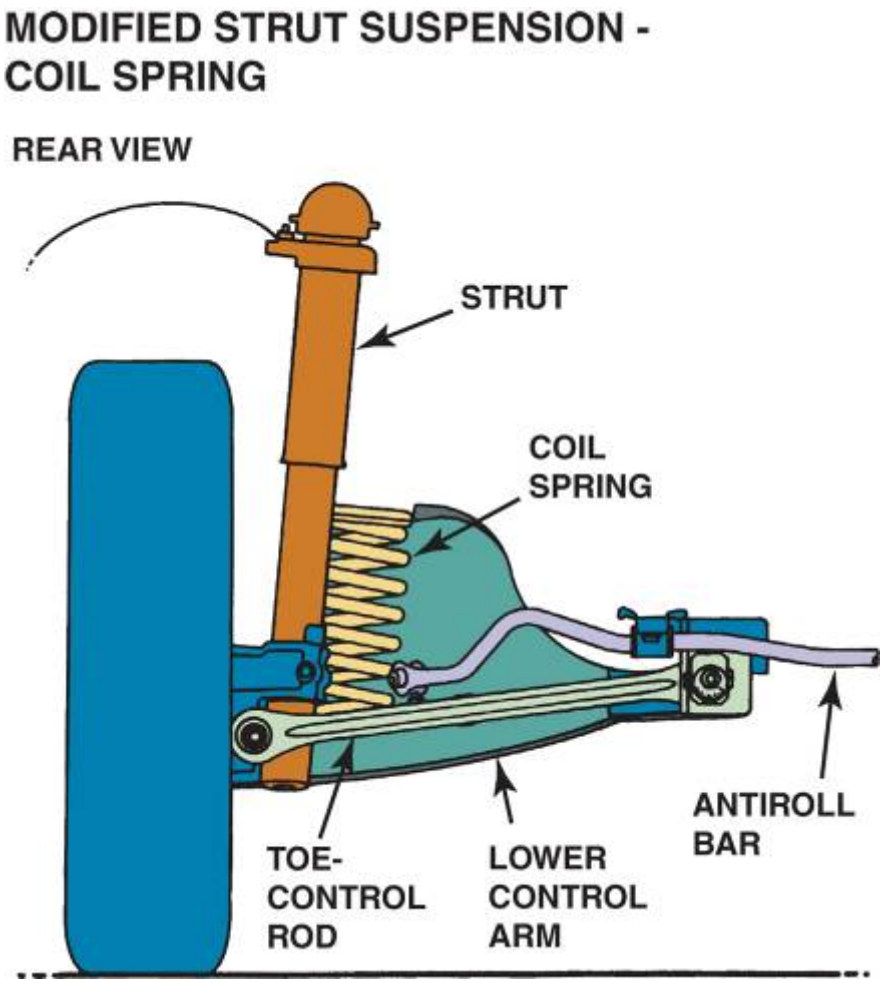

FIGURE 26–13 The toe-control rod provides an extra brace to keep the rear wheels straight ahead during braking and acceleration on this modified-strut-type independent rear suspension.

INDEPENDENT REAR SUSPENSIONS

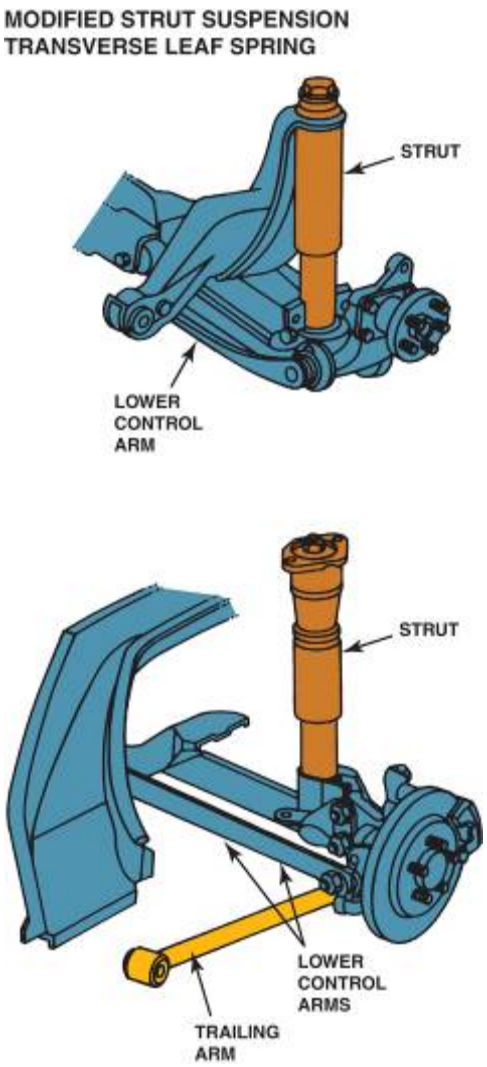

FIGURE 26–14 The upper drawing shows a transverse leafspring-type independent rear suspension that uses an “H”-shaped lower control arm. The lower drawing shows a transverse leaf spring suspension that uses two parallel lower links and a trailing arm.

SEMI-INDEPENDENT REAR SUSPENSIONS

- A **semi-independent suspension** is used only at a nondriven rear axle.
- The semi-independent design is based on a crossbeam that is similar to the beam axle of a solid, nondriven rear suspension.
  - However, on a semi-independent design the crossbeam is placed ahead, rather than at the centerline, of the wheels.

SEMI-INDEPENDENT REAR SUSPENSIONS

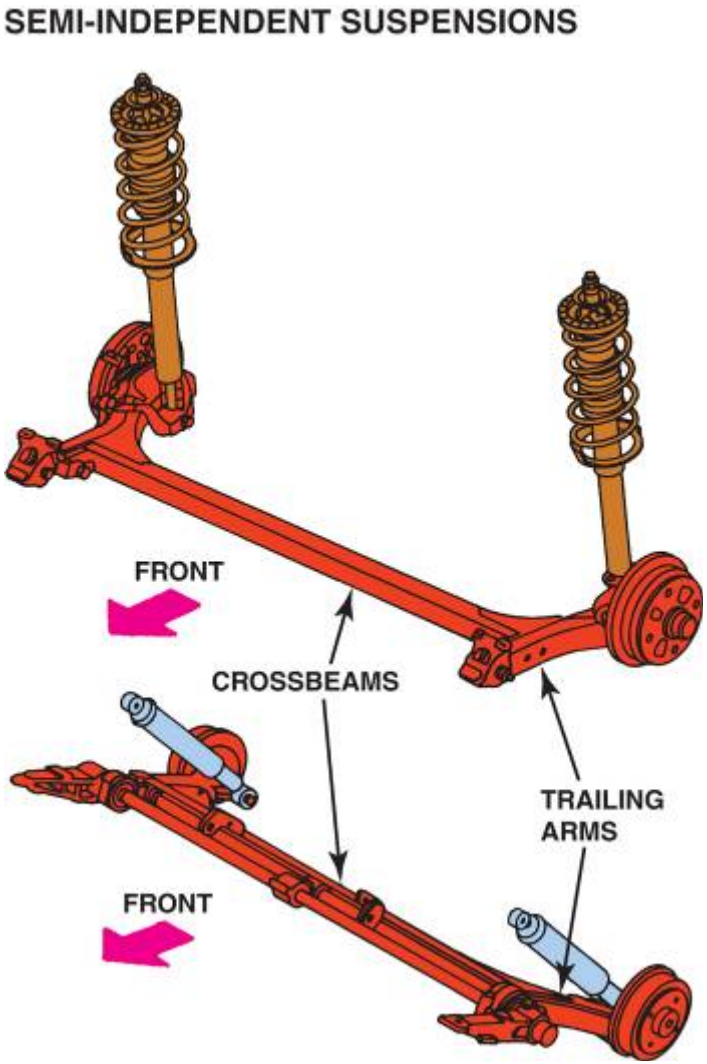

FIGURE 26–15 The crossbeam is placed toward the front of the vehicle rather than the centerline of the rear wheels on a semi-independent-type rear suspension.

SEMI-INDEPENDENT REAR SUSPENSIONS

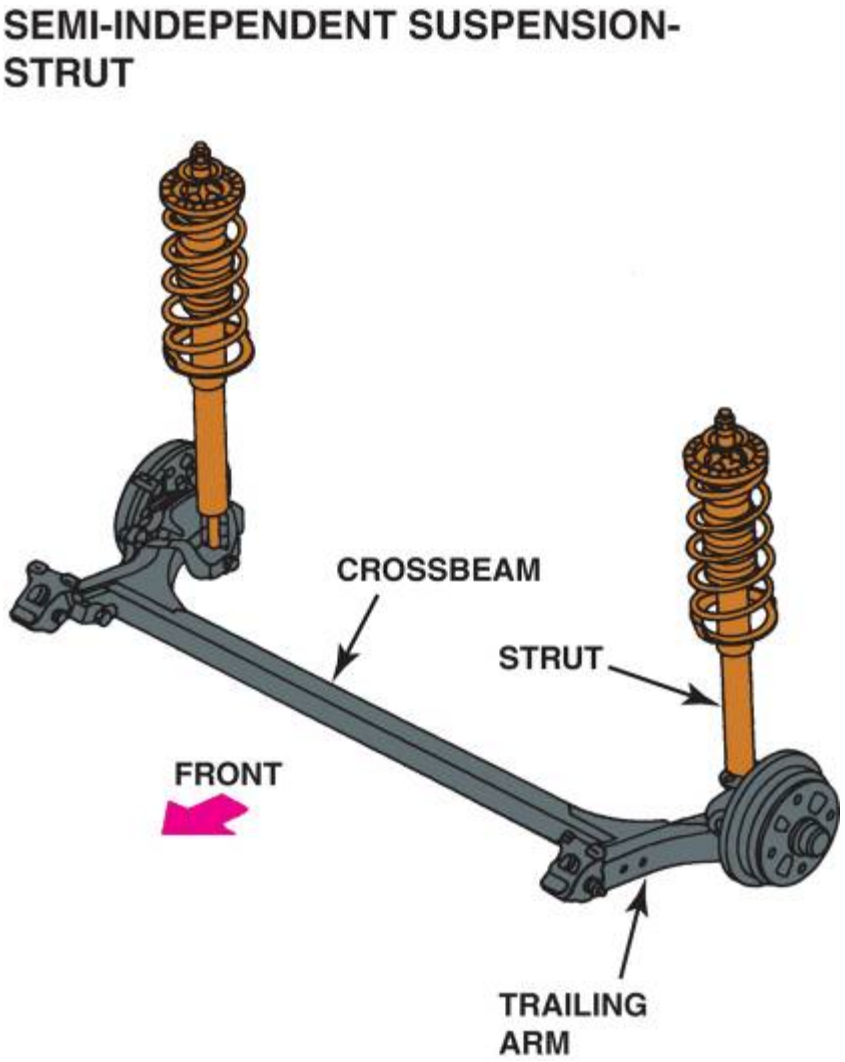

FIGURE 26–16 A semi-independent rear suspension with MacPherson struts.

REAR SUSPENSION SERVICE

- Rear suspension service starts with a thorough test drive, to observe any unusual noises or vibrations that may be caused by a fault with a rear suspension component.
- After a test drive, safely hoist the vehicle and perform a thorough visual inspection.
- Use an appropriate prybar and move all of the bushings and joints, checking for deterioration or freeplay.

REAR SUSPENSION SERVICE

FIGURE 26–17 Check all rubber bushings for excessive cracking.

REAR SUSPENSION SERVICE

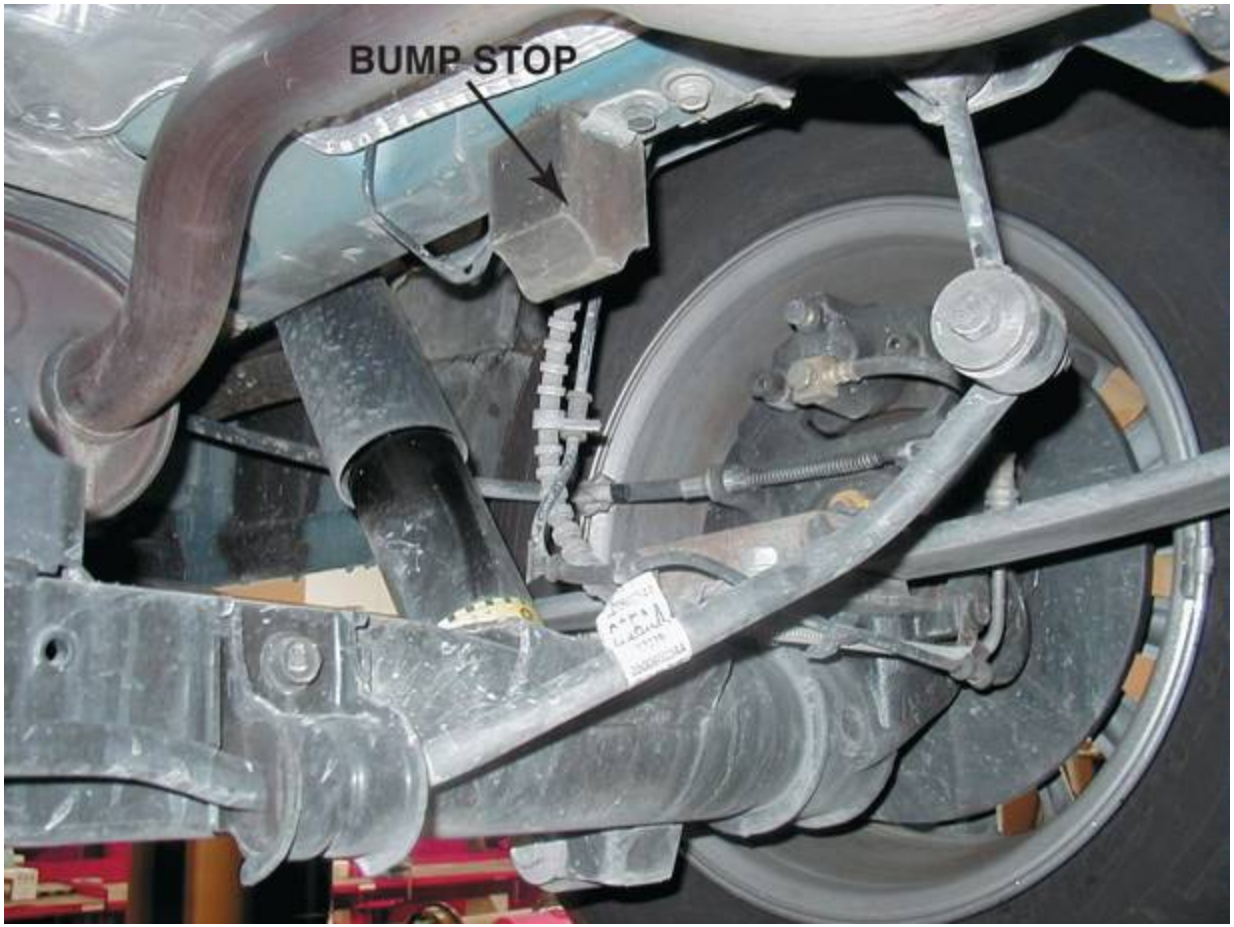

FIGURE 26–18 Carefully inspect the bump stops for damage during a thorough visual inspection.

REAR SUSPENSION SERVICE

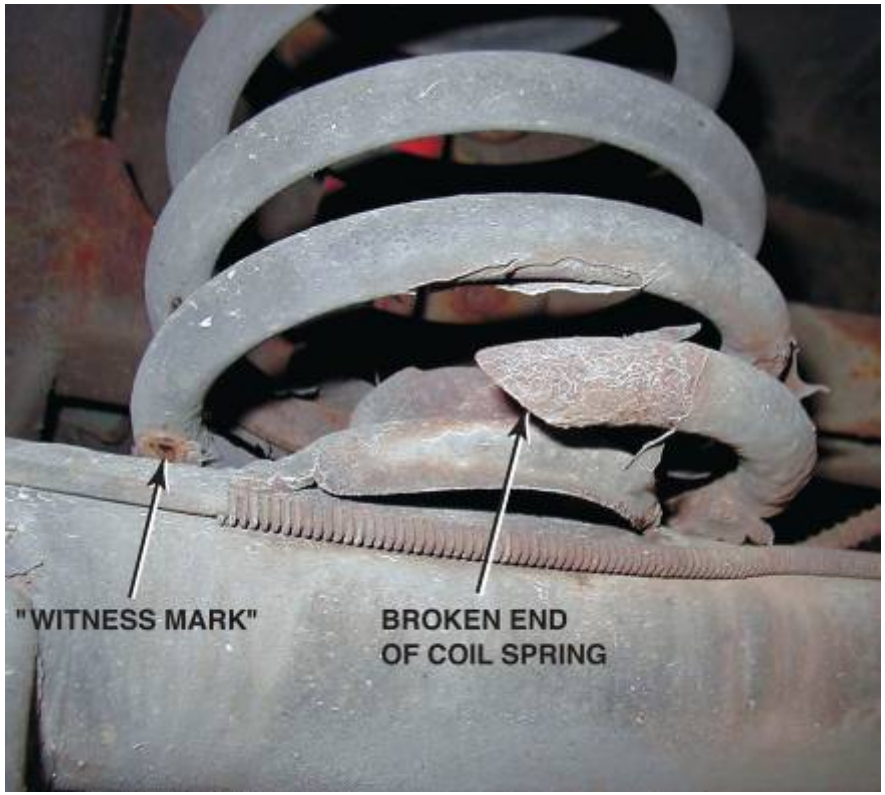

FIGURE 26–19 A broken spring was discovered during a routine under-vehicle visual inspection. Notice the witness marks that show that the spring coils have been hitting each other.

REAR SHOCK REPLACEMENT
PRECAUTIONS

- Before removing the rear shock absorbers, the rear axle must be supported to prevent stretching of the rear brake flexible hose.
- Shocks are attached to the frame or body of the vehicle at the top and to a bracket on the rear axle housing at the bottom.
- Often, the top of the rear shock absorber is fastened *inside* the vehicle.
- Consult the vehicle manufacturer's service information for exact procedures and fastener torque values.

REAR SHOCK REPLACEMENT
AIR SHOCK INSTALLATION

- The plastic air shock line attaches to the shock absorber with an O-ring or brass ferrule and nut.
- An air leak can result if this O-ring or ferrule is not installed according to the manufacturer's recommendations.
- Route the plastic air line along the body, keeping it away from the exhaust and any other body parts where the line could be damaged.
- Attach the line to both shocks to a junction at a convenient location for adding or releasing air.

REAR SPRING REPLACEMENT
REAR COIL SPRINGS

- Coil springs in the rear are easily replaced on both front-wheel-drive and rear-wheel-drive vehicles.
- The procedure includes the following steps:
  - Raise the vehicle safely on a hoist.
  - Remove both rear wheels.
  - Support the rear axle assembly with tall safety stands.
  - Remove the lower shock absorber mounting bolts/nuts and disconnect the shock absorber from the rear axle assembly.
  - Slowly lower the rear axle assembly by either lowering the height of the adjustable safety stands or raising the height of the vehicle on the hoist.
  - Lower the rear axle just enough to remove the coil springs.

REAR SPRING REPLACEMENT
REAR COIL SPRINGS

FIGURE 26–20 The shock absorber needs to be disconnected before removing the coil spring. Installation is the reverse of removal procedure.

REAR SPRING REPLACEMENT
REAR LEAF SPRINGS

- Rear leaf springs often need replacement due to one of the following common causes:
  - **Individual leaves of a leaf spring often crack, then break**
  - **If the center bolt breaks,** the individual leaves can move and the rear axle is no longer held in the correct location.

REAR SPRING REPLACEMENT
REAR LEAF SPRINGS

- To replace leaf springs in the rear of a rear-wheel-drive vehicle, follow these steps:
  - Raise the vehicle safely on a hoist.
  - Support the rear axle with safety stands.
  - Remove the rear shackle bolts and forward mounting bolt or mounting bracket.
  - Remove the U-bolts.
  - Being careful of any nearby brake line, remove the spring.
  - Install the new spring, being careful to position the center bolt correctly into the hole on the axle pedestal.

SUMMARY

1. Solid rear axles are commonly used on rear-wheel-drive and front-wheel-drive vehicles.
2. A Hotchkiss rear suspension uses the leaf springs to absorb axle windup.
3. Trailing arms run parallel to the centerline of the vehicle and are used to locate a solid rear axle.
4. A track rod (Panhard rod) or watts linkage is used to keep the rear axle centered under the vehicle.
5. Independent rear suspension (IRS) usually uses coil springs but can use a transversely mounted leaf spring.
6. The rear suspension should be supported whenever replacing the rear shock absorbers.

REVIEW QUESTIONS

1. What are the disadvantages of a solid rear axle?
2. What is the purpose of a torque arm?
3. What must be done to ensure safety when replacing the rear shock absorbers?

CHAPTER QUIZ

1. A vehicle equipped with a coil spring front suspension and a leaf spring rear suspension "dog tracks" while driving on a straight, level road. Technician A says that a broken center bolt could be the cause. Technician B says defective rear shock absorbers could be the cause. Which technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

CHAPTER QUIZ

2. When axle windup is controlled by the rear-leaf spring during acceleration, this system is called _____.
   a. Trailing arm
   b. Semi-trailing arm
   c. Torque arm
   d. Hotchkiss drive

CHAPTER QUIZ

3. A loud “bang” is heard and felt every time the accelerator is depressed or released on a rear-wheel-drive vehicle. Technician A says that a leaking shock absorber could be the cause. Technician B says a broken torque arm could be the cause. Which technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

CHAPTER QUIZ

4. Technician A says that leaf springs are mounted lengthwise on the rear of many vehicles. Technician B says that some vehicles use a transversely mounted leaf spring on the rear. Which technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

CHAPTER QUIZ

5. A strut-type suspension is used _____.
   a. In the front only
   b. In the rear only
   c. In both the front and rear
   d. In rare vehicles no longer in production

CHAPTER QUIZ

6. Two technicians are discussing rear shock absorbers. Technician A says that if one shock is leaking, then both rear shock absorbers should be replaced. Technician B says that the rear axle should be supported before removing rear shock absorbers. Which technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

CHAPTER QUIZ

7. A “witness mark” is a_____.
   a. Type of fastener
   b. Type of tool
   c. Mark where two parts have rubbed or touched
   d. Identification mark

CHAPTER QUIZ

8. The left front of the vehicle is higher than the right front and the right rear is lower than the left rear. What is the most likely cause of this problem?
   a. A weak right-rear shock absorber
   b. A broken track rod
   c. A broken left-front shock absorber
   d. A sagging right-rear spring

CHAPTER QUIZ

9. One rear leaf spring is broken. Technician A says that both rear leaf springs should be replaced. Technician B says that only the broken spring needs to be replaced. Which technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

CHAPTER QUIZ

10. A track rod is also called a _____.
    a. Panhard rod
    b. Control rod
    c. Handing link
    d. Semi-independent rod