FIGURE 24.1 A typical truck frame is an excellent example of a ladder-type frame. The two side members are connected by a crossmember.

FIGURE 24.2 Rubber cushions used in body or frame construction isolate noise and vibration from traveling to the passenger compartment.
FIGURE 24.3A Separate body and frame construction.

FIGURE 24.3B Unitized construction: the small frame members are for support of the engine and suspension components.

FIGURE 24.4 Welded metal sections create a platform that combines the body with the frame using unit-body construction.
FIGURE 24.5 Solid I-beam axle with leaf springs.

FIGURE 24.6 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.

FIGURE 24.7 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.
FIGURE 24.8 This spring was depressed 4 inch due to a weight of 2,000 lb. This means that this spring has a spring rate (K) of 500 lb per inch (2,000 ÷ 4 in. = 500 lb/in.).

FIGURE 24.9 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).

FIGURE 24.10 Coil spring ends are shaped to fit the needs of a variety of suspension designs.
FIGURE 24.11 A constant-rate spring compresses at the same rate regardless of the amount of weight that is applied.

FIGURE 24.12 Variable-rate springs come in a variety of shapes and compress more slowly as weight is applied.

FIGURE 24.13 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.
**FIGURE 24.14** Stiffer springs bounce at a higher frequency than softer springs.

**FIGURE 24.15** The wheel and arm act as a lever to compress the spring.

**FIGURE 24.16** The spring cushion helps isolate noise and vibration from being transferred to the passenger compartment.
FIGURE 24.17 This replacement coil spring is coated to prevent rust and corrosion and colored to help identify the spring and/or spring manufacturer.

FIGURE 24.18 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.

FIGURE 24.19 A typical leaf spring installation. The longest leaf, called the main leaf, attaches to the frame through a shackle and a hanger.
FIGURE 24.20 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.

FIGURE 24.21 When a leaf spring is compressed, the spring flattens and becomes longer. The shackles allow for this lengthening.

FIGURE 24.22 Typical rear leaf—spring suspension of a rear-wheel-drive vehicle.
FIGURE 24.23 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.

FIGURE 24.24 Many pickup trucks, vans, and sport-utility vehicles (SUVs) use auxiliary leaf springs that contact the other leaves when the load is increased.

FIGURE 24.25A A fiberglass spring is composed of long fibers locked together in an epoxy (resin) matrix.
FIGURE 24.25B When the spring compresses, the bottom of the spring expands and the top compresses.

FIGURE 24.26 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.

FIGURE 24.27 Longitudinal torsion bars attach at the lower control arm at the front and at the frame at the rear of the bar.
FIGURE 24.28 One end of the torsion bar attaches to the lower control arm and the other to an anchor arm that is adjustable.

FIGURE 24.29 The spindle supports the wheels and attaches to the control arm with ball-and-socket joints called ball joints.

FIGURE 24.30 The strut rods provide longitudinal support to the suspension to prevent forward or rearward movement of the control arms.
FIGURE 24.31 The steering knuckle used on a short/long-arm front suspension.

FIGURE 24.32 A kingpin is a steel shaft or pin that joins the steering knuckle to the suspension and allows the steering knuckle to pivot.

FIGURE 24.33 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.
FIGURE 24.34 Ball joints provide the freedom of movement necessary for steering and suspension movements.

FIGURE 24.35 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.

FIGURE 24.36 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.
FIGURE 24.37 All ball joints, whether tension or compression loaded, have a bearing surface between the ball stud and socket.

FIGURE 24.38 A strut rod is the longitudinal support to prevent front-to-back wheel movement.

FIGURE 24.39 Strut rod bushings insulate the steel bar from the vehicle frame or body.
FIGURE 24.40 Typical stabilizer bar installation.

FIGURE 24.41 As the body of the vehicle leans, the stabilizer bar is twisted. The force exerted by the stabilizer bar counteracts the body lean.

FIGURE 24.42 Stabilizer bar links are sold as a kit consisting of the long bolt with steel sleeve and rubber bushings.
A high-performance stabilizer bar that uses a urethane bushing instead of a rubber bushing used in most vehicles.

Movement of the vehicle is supported by springs without a dampening device. Spring action is dampened with a shock absorber. 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.

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.
FIGURE 24.46 When a vehicle hits a bump in the road, the suspension moves upward. This is called compression or jounce. Rebound is when the spring (coil, torsion bar, or leaf) returns to its original position.

FIGURE 24.47A A cutaway drawing of a typical double-tube shock absorber.

FIGURE 24.47B Notice the position of the intake and compression valve during rebound (extension) and jounce (compression).
FIGURE 24.48 Oil flow through a deflected disc-type piston valve. The deflecting disc can react rapidly to suspension movement.

FIGURE 24.49 Gas-charged shock absorbers are manufactured with a double-tube design similar to conventional shock absorbers and with a single or monotube design.

FIGURE 24.50 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.
FIGURE 24.51A The front suspension of a Lincoln with an air-spring suspension.

FIGURE 24.51B Always check in the trunk for the cutoff switch for a vehicle equipped with an air suspension before hoisting or towing the vehicle.

FIGURE 24.52 Some air springs are auxiliary units to the coil spring and are used to control ride height while the coil spring is the weight-bearing unit.
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.

The shock absorber is on the right and the fluid reservoir for the shock is on the left.

A strut is a structural part of the suspension and includes the spring and shock absorber in one assembly.
FIGURE 24.56 A modified strut used on the rear suspension; it is the structural part of the assembly.

FIGURE 24.57 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.

FIGURE 24.58 A bad suspension bumper (strike-out bumper) that was likely caused by a defective shock absorber. Both will require replacement.