After studying this chapter, you will be able to:

- Identify types of drive axles and drive shafts.
- Explain the design and construction of constant velocity flexible joints.
- Explain the design and construction of cross-and-roller flexible joints.
- Explain the purpose of antifriction bearings.
- Identify types of wheel bearings.
- Match axle types to bearing types.
- Identify types of hubs and axle flanges.
- Identify types of wheel rims.
- Explain rim size specifications.
- Identify tire designs.
- Explain tire ratings.
- Identify wheel fastener designs.

Technical Terms

<table>
<thead>
<tr>
<th>Independent drive axles</th>
<th>Ball bearings</th>
<th>Aspect ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV axles</td>
<td>Straight roller bearings</td>
<td>Load index</td>
</tr>
<tr>
<td>Transfer shaft</td>
<td>Tapered roller bearings</td>
<td>Speed rating</td>
</tr>
<tr>
<td>Drive shaft</td>
<td>Wheel hub</td>
<td>Uniform tire quality grading system</td>
</tr>
<tr>
<td>Yokes</td>
<td>Axle flange</td>
<td>Temperature resistance rating</td>
</tr>
<tr>
<td>Slip yoke</td>
<td>Wheel rims</td>
<td>Traction rating</td>
</tr>
<tr>
<td>Constant velocity joints</td>
<td>Radial tires</td>
<td>Tread wear rating</td>
</tr>
<tr>
<td>Universal joint</td>
<td>Bias tires</td>
<td>Wheel studs</td>
</tr>
<tr>
<td>Cross-and-roller joints</td>
<td>Tire ratings</td>
<td>Lug nuts</td>
</tr>
<tr>
<td>Antifriction bearings</td>
<td>Section width</td>
<td>Tire pressure monitoring systems</td>
</tr>
</tbody>
</table>
Drive Shafts

All rear-wheel drive vehicles use a drive shaft to transfer engine power from the transmission to the rear axle. Drive shafts are large hollow tubes that are carefully balanced to reduce vibration. Flexible joints are installed at each end through yokes, which are the mounting points for the joints. Figure 12-5 is an illustration of a typical rear-wheel-drive drive shaft. Four-wheel drive vehicles have a front drive shaft that directs power from the four-wheel drive transfer case to the front axle, Figure 12-6.

Independent Drive Axles

Independent drive axles are usually called CV axles because they use a type of flexible joint called a CV joint. All front-wheel drive vehicles, as well as a few rear-wheel drive cars, use CV axles. CV axles are solid steel shafts that connect the transaxle output shafts to the wheels. A few high-performance or sports cars use an independent rear axle, with exposed drive shafts containing CV joints. The construction of these shafts is the same as those used on a front-wheel drive vehicle. Some older independent rear axle shafts use U-joints instead of CV joints.

Solid Drive Axles

On most rear-wheel drive cars and trucks, the drive axles are solid steel shafts. The shafts extend from the differential assembly gears to the wheel rims. Inside the axle housing, external splines on the axle shafts mate with internal splines on the differential gears. The shafts are enclosed in the rear axle housing and are supported by bearings. Solid axle shafts are held in place by one of two methods. One design locks the shaft in place with an external retainer behind the brakes, while the other secures the shaft with a C-lock located inside of the differential assembly. Each design is shown in Figure 12-3.

Seals keep lubricant from leaking from the axle housing. Remember from Chapter 7 that the rear axle may be called a Hotchkiss axle or a Salisbury axle, depending on the wheel. This reduces vibration and strain on the CV axle components. Transfer shafts are used on large cars and on cars with manual transaxles when there is a large distance between the transaxle case and the wheels.

Some drive shafts are two-piece types. Figure 12-7. Two-piece drive shafts are usually used on large trucks, where a single drive shaft would be overstressed and break, and on some luxury cars, where any vibration would be objectionable. When a two-piece drive shaft is used, an extra flexible joint is necessary.

Slip Yoke

When the rear wheels move up and down, the distance between the transmission and rear axle assembly...
Flexible Joints

The purpose of all flexible joints is the same: to allow the drive axle or drive shaft to rotate through an angle. Since the transmission or transaxle is attached to the vehicle's body and the drive wheels move with the road surfaces, the angle between each end of the drive axle changes constantly. To do this, the joint must be able to move through an angle. Several flexible joint designs are used, including constant velocity joints and universal joints.

Constant Velocity Joints

Constant velocity joints, or CV joints, are used on all front-wheel drive vehicles and a few rear-wheel drive vehicles. The advantage of a CV joint is that it can transfer rotation through various angles with no variations in drive shaft speed. The design of a typical CV joint allows the center of rotation to change without any change in speed between the two sides of the joint. See Figure 12-14. The CV joint can also compensate for changes in drive axle length as the wheels move in relation to the transaxle. For this reason, CV joints are sometimes called plunging joints.

There are two kinds of CV joints: the Rzeppa joint and the tripod joint. Placement of the two joints varies, but as a general rule the Rzeppa joint is the joint nearest the wheel, and the tripod joint, when used, is the joint nearest the transaxle. Both types are discussed below.

Rzeppa Joints

The Rzeppa joint consists of a series of ball bearings installed between two sets of channels, or races. A sheet metal cage holds the balls in place. For this reason the Rzeppa joint is sometimes called a ball-and-cage joint. A typical Rzeppa joint is shown in Figure 12-11. One race is external; the other race is internal. The internal and external races are connected to opposite sides of the drive axle. Power flows through one race, through the balls, and into the other race. Figure 12-12 shows the relationship between the internal parts and the drive axle of a typical Rzeppa joint. The ball bearings can turn to compensate as the angle between the inner and outer races changes.

Tripod Joints

Tripod joints are also constant velocity joints. They consist of a three-pointed assembly called a spider. Transmissions on the spider allow the spider to move along internal channels in a housing. A typical tripod joint is shown in Figure 12-13. Note that the spider is splined to the axle shaft. Thin roller bearings called needle bearings are installed between the spider points and the trunnions. As the axle rotates, the spider is driven by the housing and drives the shaft. If the angle between the two sides of the joint changes, the tripod can tilt to compensate. See Figure 12-14. The spider can also move back and forth inside of the housing to compensate for changes in axle length as the wheels move up and down over road irregularities.

CV Joint Lubrication

Special grease is used to lubricate CV joints. This grease resists water and forms a film that retards corrosion of the CV joint parts. It is supplied in plastic packets that are packaged with replacement CV joints and boots. Ordinary front-end greases should never be used to lubricate a CV joint.

Centrifugal force tends to throw lubricant out of a CV joint. To keep grease from leaving the joint and protect the joint from dirt and water, CV boots are installed over the joint.

As the grease is thrown outward, it strikes the inner cover of the boot. When the vehicle stops, the grease flows back into the joint. The accordion pleats on the boot allow the joint to move in and out as it compensates for changes in axle length. CV boots are held in place by boot clamps. Typical CV boots are shown in Figure 12-15.

Universal Joints

The universal joint, or U-joint, is used on drive shafts. Sometimes U-joints are used on the transfer shaft of a front drive axle. U-joints are often called cross-and-roller joints or Cardan joints. The basic U-joint consists of a central four-pointed cross, or spider, with caps that contain needle bearings. The caps are attached to yokes on the drive shaft and corresponding parts. As the drive shaft turns through an angle, the cross twists within the caps. The needle bearings reduce friction and vibration. A typical U-joint is shown in Figure 12-16.
Wheel Components

The following sections cover the components related to a vehicle's wheels. These components, which include the wheel hubs, bearings, rims, tires, and fasteners, are found on both driving and non-driving axles.

Wheel Bearings

The wheel bearings form a low-friction connection between the rotating wheels and the stationary vehicle. All wheel bearings are antifriction bearings. Antifriction bearings consist of three basic parts: the inner race, the rolling element, and the outer race. See Figure 12-18. The rolling elements rotate between the two races, allowing the races to move in relation to each other with a minimum of friction. The rolling action also draws lubricant between the moving parts. The rolling elements and races are made of heat-treated steel for maximum durability.

Due to their design, cross-and-roller U-joints do not require a surrounding boot. Seals at the ends of the bearing caps (where they enter the cross) keep lubricant in and water and dirt out. Many U-joints are equipped with grease fittings. Conventional front suspension lubricant can be used to lubricate U-joints.

In operation, the cross of the U-joint transmits power between the two yokes. Since the cross cannot move back and forth, the drive angle changes as the shaft rotates through an angle. This causes the speed of the driven part of the drive shaft to vary. See Figure 12-17. The greater the angle, the more the vibration. For this reason, U-joints are used only where the angle between the yokes is relatively small.

Figure 12-11. Exploded view of a Rzeppa (ball-type) constant velocity joint. (AC Delco)

Figure 12-12. The balls in a Rzeppa joint operate in a bisecting plane between the angles of the axle shafts. As the joint revolves, the position of the balls will change so they remain in this bisecting plane. The position of the balls is controlled by elongated openings in the cage. (AC Delco)

Figure 12-13. Exploded view of a tripod constant velocity joint. (AC Delco)

Figure 12-14. Tripod joint operation. The tripod joint uses three balls on needle bearings to transmit torque between the spider (spined to the axle shaft) and the housing. As the joint revolves, the three balls will change their positions to stay in the same plane as the spider. The balls can move in and out of the housing to allow for length changes as the suspension travels up and down. (AC Delco)

Wheel Bearings

The wheel bearings form a low-friction connection between the rotating wheels and the stationary vehicle. All wheel bearings are antifriction bearings. Antifriction bearings consist of three basic parts: the inner race, the rolling element, and the outer race. See Figure 12-18. The rolling elements rotate between the two races, allowing the races to move in relation to each other with a minimum of friction. The rolling action also draws lubricant between the moving parts. The rolling elements and races are made of heat-treated steel for maximum durability.

The clearances between the parts of an antifriction bearing must be tight enough to prevent unwanted movement and vibration. However, the clearances must be loose enough to keep friction at a minimum, allow lubricant to enter between the moving parts, and compensate for expansion as bearing temperature increases.

Other parts of antifriction bearings include the bearing cage, which keeps the individual rolling elements separated as they turn, and seals or shields, which keep lubricant in and dirt and water out.
Wheel Bearing Design

Wheel bearings must be carefully selected to deal with types of loads, maximum bearing speed, where the bearing will be used on the vehicle, and what the vehicle is used for. Overall bearing size, as well as the size of the rolling elements, must be determined to give the longest service without unnecessary friction and wear.

Another factor that must be calculated carefully is bearing preload. Preload is the amount of pressure placed on the bearing before it is put into service. In other words, preload is how tightly the rolling elements and races fit together before other loads are placed on the bearing. Too little preload will cause the rolling elements to rock and vibrate, damaging the bearing. Insufficient preload also intensifies the effect of shock loads. Too much preload will press the rolling elements too tightly against the races, creating unnecessary friction and heat.

Axial loads occur when the vehicle is turned. The steering linkage turns the front wheels, but the body wants to keep moving forward. In the rear, the tires tend to keep moving in the same direction while the vehicle body is turning. This places a sideways, or axial, load on the bearings. See Figure 12-20. Axial loads are sometimes called thrust loads. Axial loads are always parallel to the shaft.

Wheel Bearing Types

All modern wheel bearings are antifriction types. Three types of antifriction bearings are used on late-model vehicles: ball bearings, straight roller bearings, and tapered roller bearings. The type of bearing used varies with the weight placed on the bearing, whether it is used on a steering or non-steering axle, and whether it is used on a driving or non-driving axle.

Ball Bearings

Ball bearings are used on the front axles of some front-wheel drive vehicles. Most of these applications use two ball bearing assemblies. In some cases, two rows of bearings are contained in a single housing. A dual ball bearing assembly is shown in Figure 12-21. In addition to splitting the weight, each bearing assembly can take axial loads in one direction. Pairing the ball bearings handles axial loads in both directions. Note in Figure 12-22 the inner and outer races are designed to accept axial loads in opposite directions. Modern ball bearings have the balls and races in a single sealed unit. Preload is factory set and cannot be adjusted.

Figure 12-20. Two roller bearing applications illustrating axial (thrust) loading. Note that the thrust load is parallel to the shaft or housing. (Federal-Mogul)

Straight Roller Bearings

Straight roller bearings, Figure 12-23, are used on the rear axles of many rear-wheel drive vehicles. Flat roller bearings can absorb radial loads, but they cannot handle axial loads. Straight roller bearing assemblies are self-contained units, and preload is not adjustable. On a few older cars, the axle shaft serves as the inner race.

Figure 12-21. A dual ball bearing assembly used on the front axle hub. Note the speed sensor rotor, which is used by the anti-lock brake system. Do not damage rotors when working with bearings, hubs, etc. (Lexus)

Tapered Roller Bearings

Tapered roller bearings are used in both front and rear axles. They can be found on driving and non-driving axles. Their tapered design allows them to handle any combination of axial and radial loads. As with ball bearings, tapered roller bearings are installed in pairs to absorb sideways loads. See Figure 12-24. On most tapered roller bearing designs, the inner race, rollers, and cage are a single unit. The outer race is pressed into the hub.

Straight roller bearings, Figure 12-23, are used on the rear axles of many rear-wheel drive vehicles. Flat roller bearings can absorb radial loads, but they cannot handle axial loads. Straight roller bearing assemblies are self-contained units, and preload is not adjustable. On a few older cars, the axle shaft serves as the inner race.

Tapered Roller Bearings

Tapered roller bearings are used in both front and rear axles. They can be found on driving and non-driving axles. Their tapered design allows them to handle any combination of axial and radial loads. As with ball bearings, tapered roller bearings are installed in pairs to absorb sideways loads. See Figure 12-24. On most tapered roller bearing designs, the inner race, rollers, and cage are a single unit. The outer race is pressed into the hub.
stationary vehicle. On most vehicles, the hub is also the mounting surface for the brake drum or rotor. On non-driving axles, the hub often contains the bearing races. Note the relationship between the hub, the tapered roller bearings and the spindle in Figure 12-30. This design is often used on front or rear non-driving wheels.

The front hubs used on many front-wheel drive vehicles are pressed onto the axle. Splines on the hub and the axle allow the axle to drive the hub. The hub may be pressed into the bearings.

When solid axles are used, such as on the rear of rear-wheel drive vehicles, the axle and drum are connected through the use of an axle flange, Figure 12-31. The axle flange is forged as part of the axle, or it is welded on later. The flange forms a mounting surface for the wheel assembly.

Wheel Rims

Wheel rims are the connection between the hub and the tire. The tire is installed on the rim, and the rim is bolted to the hub.

Rim Construction

In many cases, rims are made of stamped steel, Figure 12-32. Parts of the rim are stamped into shape and then welded into a final form. The center section contains the wheel mounting holes. On some wheels, an extra stamping is used to attach the wheel cover, Figure 12-33. The flange holds the tire in place once it is installed and inflated.

Steel rims are relatively light and reduce the amount of unsprung weight. They are also durable and cheap to manufacture. Some steel rims are chrome plated for appearance, while others are painted and used with wheel covers.

Modern vehicles are increasingly using rims made of materials other than steel. These rims are usually called custom rims. Common materials for custom rims are aluminum, aluminum-magnesium alloys, and composites of graphite and plastic. Figure 12-34 shows a typical custom wheel.
The rim design used today is called the drop-center wheel. The center section of the rim is lowered (or dropped), which allows the tire to be pulled to one side for easier removal. Most rims have a small ridge behind the tire bead to hold the tire in place if a blowout occurs. These are called safety rims. See Figure 12-35.

**Rim Sizes**

There are three measurements of rim sizes. The rim diameter is most commonly used to describe the rim size. Rim width is the size of the rim between the flanges. The flange height is how far the flange extends above the bead seat. Figure 12-36 illustrates the three measurements of a rim. These measurements apply to both steel and custom wheels.

![Figure 12-35. A safety rim holds the tire in place in the event of a blowout. (Chrysler)](image)

**Tires**

Tires perform two jobs: they cushion shocks and provide traction. In their role as cushioning devices, they can be considered part of the suspension system. As traction devices, they transmit engine power, as well as braking and turning efforts, to the road.

**Tire Construction**

The external parts of the tire are the tread and the sidewalls. Tread designs vary depending on the tire's application. The sidewalls form the support for the treads. The tread and sidewalls are a blend of natural rubber and a synthetic rubber called neoprene.

The internal parts of the tires are composed of plies and belts. The plies are layers of tire cord that form the general shape of the tire. Tire cords can be made of various fabric materials, including nylon, rayon, polyester, aramid, Kevlar, or fiberglass. The belts are installed directly under the tread and can be made of the same materials as the plies. Some belts are made of steel.

All modern tires are radial tires. In a radial tire, the cords in the plies cross the centerline of the tire at a right angle to the tread. Older tires were called bias tires. In a bias tire, the cords cross the centerline on a bias, or a slant.

Almost all radial tires have one or two belts, which reduce tread squirming, Figure 12-37.

![Figure 12-37. Typical construction of a radial tire. Sidewall plies are parallel with each other and at right angles to tread centerline. Belts are under tread area. (Firestone)](image)

**Tire Ratings**

Modern tire ratings are designated by a system that uses a series of numbers and letters. The ratings are stamped into or molded into the tire's sidewall. An example of the rating that would be found on the sidewall of a typical tire is given in Figure 12-38.

The letter P designates the tire as a passenger car tire, Figure 12-39. Other letters used in this position are LT for light truck, T for temporary (such as a space saver spare), and C for commercial (large trucks and construction vehicles). On tires that are suitable for both cars and trucks, this letter is not used.

The number 205 is the section width, which is measured at the tire's widest point. The section width is a good indication of tread width, and is generally considered to be the tire size. The section width ranges from about 175 on small tires to about 235 on large tires.

The number 70 is the aspect ratio, or the relationship of the tire section width to its height, Figure 12-39. Low numbers indicate a wide, low tire. The larger the number, the taller the tire.

The letter T indicates a radial tire. Other letters that could appear here are B and D for bias and belted tires.

The number 15 is the rim size in inches. The most common rim sizes are 13, 14, and 15. A few vehicles have 12-, 16-, or 17-inch rims, but these are uncommon.

The number 95 is the load index. The load index is an assigned number that corresponds to the amount of axle weight the tire can carry. In this case, a 95 load index indicates the tire can support 1521 lb. (690 kg). Load indexes usually range from 75–110.

The letter S is the speed rating. The speed rating indicates the maximum speed at which the tire should be operated. Speed rating letters range from B, with a maximum speed of 112 mph (180 km/h), to Z, with a maximum speed of 149 mph (240 km/h). This number is also eliminated on some tires.

**Tire Quality Ratings**

As standardized by the United States Department of Transportation (DOT), tires are graded according to the uniform tire quality grading system. The tire grades are stamped on the sidewall of the tire. This grading system establishes several quality grades, including the temperature resistance rating, the traction rating, and the tread wear rating.

The temperature resistance rating rates the tire's resistance to heat generation. Note that this grade is the resistance to generating heat, not its resistance to the heat.
Wheel Fasteners
An important factor in wheel and tire design is the way the rim is mounted to the hub or axle flange. On almost all cars and trucks, the hub or axle flange contains the wheel studs, Figure 12-40. Most wheel studs are threaded bolts or studs pressed into the hub or flange. A knurled area on the rear section of the stud cuts into the thread of the bolt or stud pressed into the hub or axle metal to keep the stud from coming completely through the hole. To precisely center the hole in the hub or flange, the head keeps the stud from loosening. The head of the stud resembles a bolt head and is wider than the hole in the hub or flange. The head keeps the stud from becoming completely through the hole. To precisely center the wheel, a central part of the hub or flange is slightly raised and holds the center of the rim in position.

To install the wheel, the holes in the center section of the rim are placed over the studs and lug nuts are threaded onto the studs. The lug nuts can then be tightened in a cross or star pattern. The tapered end of each lug nut matches a tapered area in the wheel mounting hole. The matching tapers help center the wheel. On most steel wheels, the lug nuts can be tightened by hand or with an impact wrench. Custom wheels have different metal expansion rates than the steel and iron hubs, and the lug nuts must be tightened to a specific torque.

A few imported vehicles use a somewhat different design. Instead of studs, the hub or flange has threaded holes. Tapered lug bolts, Figure 12-41, are installed through the wheel and threaded into the holes. As with lug nuts, tightening is very important.

Tire Pressure Monitoring
Every set of tires has an ideal pressure for best handling, braking and tire life. Even new tires lose some air over time. For this reason, tire air pressure must be monitored and air added when necessary. The simplest way to check tire pressure is with a mechanical pressure gauge. Most drivers, however, rarely remember to check tire pressure. For this reason, many modern vehicles are equipped with a tire pressure monitoring system. The tire pressure monitoring system routinely checks pressure in each vehicle tire. If low pressure is detected, an instrument panel warning light illuminates, informing the driver that one or more tires are underinflated. The driver can then add air or have the tire(s) serviced as necessary.

Pressure monitoring systems are either direct or indirect systems. The direct pressure monitoring system consists of a central control module and wireless pressure transmitters at each wheel. The transmitters send a signal to the module. If any transmitter signals low pressure, the module illuminates an instrument panel warning light, Figure 12-42.

Indirect pressure monitoring systems do not have sensors at each tire. Instead, they use the vehicle’s anti-lock brake system, or ABS, to monitor tire pressure. Modern anti-lock brake systems have wheel speed sensors on each wheel. The ABS control module compares relative wheel speeds of all tires. When a tire loses air, the distance between the tire tread and the center of the wheel decreases. This smaller diameter causes a tire’s speed to increase. The control module reads the higher speed and compares it with the speed of the other tires. If tire speed passes a set threshold, the module turns on an instrument panel warning light.

Both systems have advantages and disadvantages. The direct system is more accurate, but requires wheel sensors, which must be handled carefully when the tire is removed from the rim. A recalibration procedure must be performed whenever tires are rotated. The indirect system does not require any wheel hardware, and recalibration is usually simpler. However, it is less accurate and cannot detect some common tire pressure problems, such as all four tires gradually losing air.

Summary
Common driveline components are the drive axles and shafts, flexible joints, and related parts. Generally, solid axles are used on rear-wheel drive vehicles and independent axles are used on front-wheel drive vehicles.
Independent drive axles are usually called CV axles. CV axles are solid steel shafts or hollow tubes that connect the transaxle output shafts to the wheels. There are always two CV axles on a front-wheel drive vehicle. Some front-wheel drive vehicles have a transfer shaft on one side. A few high-performance or sports cars use an independent rear axle with CV joints. Some older independent rear axles have U-joints.

On most cars and trucks with rear-wheel drive, the drive axles are solid steel shafts that extend from the differential assembly to the wheel hubs. Some four-wheel drive drive axles have a solid front axle. All front-engine, rear-wheel drive vehicles have a drive shaft between the transmission and rear axle. Some drive shafts are two piece types. Four-wheel drive vehicles also have a front drive shaft.

Several types of flexible joints are used on modern vehicles. The type of flexible joint used depends on the type of axle being used. CV joints are used on all front-wheel drive vehicles and some rear-wheel drives. They are able to transmit power through an angle without causing variations in shaft speed. There are two kinds of CV joints, the Rezepa joint and the tripod joint.

The Rezepa joint consists of a set of ball bearings inside of two sets of races. The ball bearings can move between the channels to compensate for changes in angle. Tripod joints consist of a three point spider and trunnions that rotate on roller bearings. The spider and trunnions are placed in a housing. As the axle rotates, the trunnions and spider are driven by the housing and tilt to compensate for angle changes. CV joint boots keep lubricant in and dirt out.

The U-joint, or Cardan joint, is used with drive shafts. U-joints consist of a four point cross and caps that turn on needle bearings. The cross can twist as it rotates to compensate for shaft angle changes. U-joints are used when the angle change between rotating parts is not too great.

Wheel bearings form a low-friction connection between the wheels and the vehicle. All wheel bearings are antifriction bearings consisting of three basic parts: the inner race, the rolling element, and the outer race. There are two kinds of bearing loads. Radial loads are caused by the weight of the vehicle and by centrifugal force. Axial loads are sideways loads that occur when the vehicle is turned.

The three types of antifriction wheel bearings are the ball bearing, the flat roller bearing, and the tapered roller bearing. Ball bearings are found on the front axles of many front-wheel drive vehicles. The balls and races are in a single sealed unit. Straight roller bearings are often used on the rear axles of rear-wheel drive vehicles. Tapered roller bearings are used in front and rear axles and are always installed in pairs to absorb sideways loads. Tapered roller bearing preload is adjustable.

Most tapered wheel bearings are packed with wheel bearing grease, which must be periodically renewed. Some ball bearings and straight roller wheel bearings are greased for life. Oil splash from the rotating gears is often used as a lubrication method on solid rear axles.

The two main classes of wheel bearing lubricants are wheel bearing greases and gear oils. Most wheel bearings are lubricated by grease. Some solid rear axle wheel bearings are lubricated with gear oil. The wheel bearings on most modern vehicles call for EP lithium grease. Wheel bearings used in solid rear axles are sometimes lubricated with the gear used to lubricate other rear axle parts. Bearing seals keep the oil or grease in, and water out.

The wheel hubs and axle flanges are the mounting surface for the wheel rims and tires. The hub may contain the bearing and a drive shaft between the transmission and rear axle. Front hubs used on front-wheel drive vehicles are often pressed onto the axle.

Wheel rims are the connection between the hub and the tire. The rim design used today is called the drop-center wheel. Rims are made of stamped steel or various alloys. Rim size determines what type of tire will be used, and is composed of diameter, width and flange height.

Most modern vehicles have use a solid centerline. The tire ratings and quality grades are stamped on or molded into the side of the tire.

The wheel rim is mounted to the hub or axle flange through wheel studs and lug nuts. A few vehicles use tapered bolts instead of lug nuts and studs.

### Review Questions—Chapter 12

1. Why are front-wheel drive independent axles called CV axles?
   - A. They allow the axle shaft to move parallel to the vehicle centerline.
   - B. They allow the axle shaft to change length.
   - C. They prevent grease loss.
   - D. There is no reason.

2. While most CV axles are _____ steel shafts, a few are _____ to reduce weight.
   - A. CV joint.
   - B. U-joint.
   - C. Too little preload will damage the bearing because of vibration.
   - D. Too little preload will create unnecessary friction and heat.

3. Technician A says that CV boots keep CV joint grease from leaching out of the joint as it turns. Technician B says that CV joints can be lubricated with any kind of quality EP grease. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

4. Why are some CV joints called plunging joints?
   - A. They allow the axle shaft to move parallel to the vehicle centerline.
   - B. They allow the axle shaft to change length.
   - C. They prevent grease loss.
   - D. There is no reason.

5. Technician A says that CV boots keep CV joint grease from leaching out of the joint as it turns. Technician B says that CV joints can be lubricated with any kind of quality EP grease. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

6. EP lubricant is a type of _____.
   - A. Hypoid oil
   - B. Gear oil
   - C. Lithium grease
   - D. Long fiber grease

7. Technician A says that the purpose of the garter spring is to hold the lip of a seal to the shaft. Technician B says that the purpose of the garter spring is to create an oil film between the shaft and lip. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

8. All of the following statements about tire construction are true except:
   - A. The cords in radial tire plies cross the centerline of the tire at a right angle to the tread.
   - B. Belts are installed directly under the tire tread.
   - C. Tire cords are made of a combination of natural rubber and neoprene.
   - D. Some belts are made of steel.

9. Which of the following is NOT a common rim size?
   - A. 12 inches.
   - B. 13 inches.
   - C. 14 inches.
   - D. 15 inches.

10. The tapered areas of the lug nut and wheel mounting holes help to _____ the wheel rim and tire.
    - A. Balance
    - B. Center
    - C. Cool
    - D. Seal

### ASE-Type Questions—Chapter 12

1. Technician A says that front-wheel drive vehicles always have four CV joints on the front axles. Technician B says that front-wheel drive vehicles always have transfer shafts. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

2. While most CV axles are _____ steel shafts, a few are _____ to reduce weight.
   - A. CV joint.
   - B. U-joint.
   - C. Too little preload will damage the bearing because of vibration.
   - D. Too little preload will create unnecessary friction and heat.

3. Technician A says that CV boots keep CV joint grease from leaching out of the joint as it turns. Technician B says that CV joints can be lubricated with any kind of quality EP grease. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

4. Why are some CV joints called plunging joints?
   - A. They allow the axle shaft to move parallel to the vehicle centerline.
   - B. They allow the axle shaft to change length.
   - C. They prevent grease loss.
   - D. There is no reason.

5. Technician A says that CV boots keep CV joint grease from leaching out of the joint as it turns. Technician B says that CV joints can be lubricated with any kind of quality EP grease. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

6. EP lubricant is a type of _____.
   - A. Hypoid oil
   - B. Gear oil
   - C. Lithium grease
   - D. Long fiber grease

7. Technician A says that the purpose of the garter spring is to hold the lip of a seal to the shaft. Technician B says that the purpose of the garter spring is to create an oil film between the shaft and lip. Who is right?
   - A. A only.
   - B. B only.
   - C. Both A and B.
   - D. Neither A nor B.

8. All of the following statements about tire construction are true except:
   - A. The cords in radial tire plies cross the centerline of the tire at a right angle to the tread.
   - B. Belts are installed directly under the tire tread.
   - C. Tire cords are made of a combination of natural rubber and neoprene.
   - D. Some belts are made of steel.

9. Which of the following is NOT a common rim size?
   - A. 12 inches.
   - B. 13 inches.
   - C. 14 inches.
   - D. 15 inches.

10. The tapered areas of the lug nut and wheel mounting holes help to _____ the wheel rim and tire.
    - A. Balance
    - B. Center
    - C. Cool
    - D. Seal