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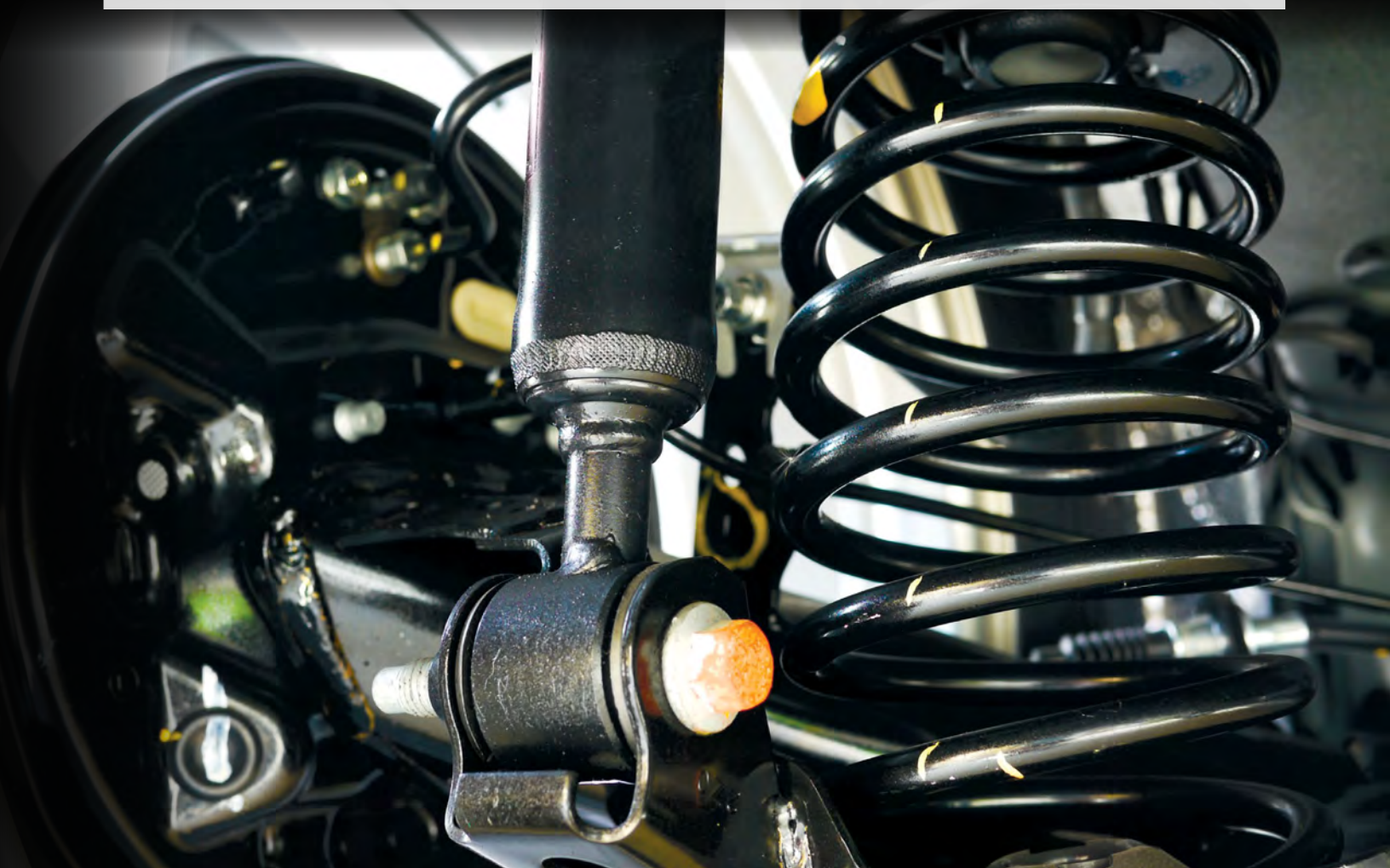

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# CONTENTS

# CHAPTER 8
# Wheel Bearing and Seal Service

## NATEF Tasks

- **N08001** Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine needed action.
- **N08002** Remove, clean, inspect, repack, and install wheel bearings; replace seals; install hub and adjust bearings.
- **N08003** Replace wheel bearing and race.
- **N08004** Remove, reinstall, and/or replace sealed wheel bearing assembly.
- **N08005** Remove, inspect, service and/or replace front and rear wheel bearings.

## Knowledge Objectives

After reading this chapter, you will be able to:

- **K08001** Describe the components of a wheel bearing.
- **K08002** Describe the advantages and disadvantages of serviceable and sealed wheel bearings.
- **K08003** Describe the difference between friction and antifriction bearings.
- **K08004** Describe advantages and disadvantages of ball and roller types of wheel bearings.
- **K08005** Describe how side load (thrust) impacts bearing selection.
- **K08006** Describe the purpose of double-row wheel bearings.
- **K08007** Describe a unitized wheel bearing hub.
- **K08008** Describe the purpose of grease seals.
- **K08009** Describe the different wheel bearing lubricant designations.
- **K08010** Describe wheel bearing end play and preload.
- **K08011** Describe the process of diagnosing wheel bearing concerns.

## Skills Objectives

After reading this chapter, you will be able to:

- **S08001** Pack wheel bearings using a bearing packer.
- **S08002** Pack wheel bearings by hand.
- **S08003** Install wheel bearings.
- **S08004** Install the locking mechanism on a wheel bearing.
- **S08005** Replace a wheel bearing and race.
- **S08006** Remove and reinstall a sealed wheel bearing using the unitized wheel bearing hub style.

## You Are the Automotive Technician

A customer brings her 2003 Ford F250 pickup truck into your shop, complaining that the vehicle is making a howling sound when driving more than 20 mph. The noise seems to gradually increase as the speed of the vehicle increases. The customer is concerned that the vehicle might break down and leave her stranded. You ask where the noise is coming from, and she explains it is coming from the center or rear of the vehicle. You notice that the truck is equipped with a solid live rear axle, and the tires are in good shape, with a fairly smooth highway tread on them.

1. On a test drive, how can you determine whether the noise is coming from a wheel bearing or a transmission bearing?
2. What bearing arrangements can be used on a solid live rear axle?
3. How are rear wheel bearings lubricated on a solid live rear axle?
4. Does this truck use a center bearing in the driveshaft?

# ▶ Introduction

Wheel bearings are a commonly overlooked component. All wheel bearings used to be the serviceable type, requiring periodic maintenance every 24,000–30,000 miles (38,624–48,280 km), consisting of disassembly, cleaning, inspecting, reassembly, and adjusting. With the introduction of sealed wheel bearings that do not need periodic service, many manufacturers switched to using them on most of their light-duty vehicles. As a result, many technicians do not give the wheel bearings as much consideration as they once did. However, both types of wheel bearings can fail, and vehicles with serviceable wheel bearings still need maintenance, so it is important that you become familiar with wheel bearings.

In this chapter, you learn about each wheel bearing component and the role wheel bearings play in helping to keep the vehicle safe. Because wheel bearings can require maintenance, you learn how to accurately diagnose common issues and recommend the proper service or repair to the customer. You also learn how to properly maintain and, if necessary, replace today's wheel bearings.

**K08001** Describe the components of a wheel bearing.

**K08002** Describe the advantages and disadvantages of serviceable and sealed wheel bearings.

**K08003** Describe the difference between friction and antifriction bearings.

**K08004** Describe advantages and disadvantages of ball and roller types of wheel bearings.

## Wheel Bearings Overview

**Wheel bearings** play a critical role in the vehicle by allowing the wheels to roll with a minimum of friction while still maintaining accurate wheel positioning under all driving conditions. Most wheel bearing assemblies include the following components: an **outer race**, an **inner race**, **roller bearings** or **ball bearings**, and a **bearing cage** to hold the rollers or balls in place (**FIGURE 8-1**). The rollers or balls are made of hardened metal and roll between the two races. The races are also made of hardened metal and are carefully formed to match the contour of the rollers or balls so all of the components roll easily against one another. Each race will either fit firmly within a housing or firmly on a shaft. In many situations, the races are an **interference fit** with the housing or shaft, which means they must be pressed into place with a high amount of force. In other words, the races are designed so as to provide the rolling function. Because the races, rollers, and balls are made of hardened metals, they are designed to resist wear and damage. However, overloading the vehicle can put the wheel bearings under a greater load than they are rated for, which can cause them to fail. In the same way, using improper or insufficient lubricant can cause them to fail. Wheel bearing failure is discussed in detail later in this chapter.

There are two categories of wheel bearings: **serviceable bearings** and **sealed bearings**. Serviceable bearings are designed so they can be disassembled and serviced, whereas sealed bearings are not. Serviceable bearings must be serviced periodically by disassembling, cleaning, inspecting, repacking them with the specified lubricant, reinstalling, and adjusting them. Sealed bearings are designed so they cannot be disassembled or adjusted. Sealed bearings are manufactured with the proper clearance and filled with the specified lubricant from the factory. They are designed to last the life of the vehicle, but bearings do wear out or fail occasionally and need to be replaced. Sealed bearing failure and replacement are discussed in detail later in the chapter. When sealed bearings are installed, they should not rotate in or on their respective components.

**▶ TECHNICIAN TIP**

Roller and ball bearing assemblies are called **antifriction bearings** because the components are in rolling contact with one another and therefore have minimal friction. A sleeve-type bearing, or bushing, such as a clutch pilot **bushing**, is called a **friction bearing**, as the components are in sliding contact with one another. Antifriction bearings run much more freely than friction bearings.

**K08009** Describe the different wheel bearing lubricant designations.

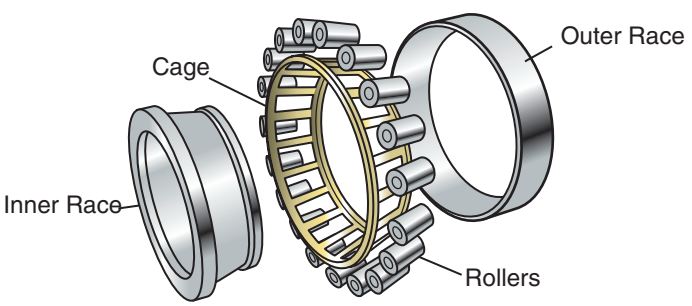



**FIGURE 8-1** Wheel bearing components.

## Wheel Bearing Lubrication

All wheel bearings require lubrication to extend their useful life. There are two common types of lubricants used—gear lube and bearing grease. Each application specifies one or the other. They cannot be substituted as each lubricant uses different housing and seal designs. Gear lube is somewhat thicker than engine oil. Because gear lube flows much easier than grease, the bearing assembly runs in a housing partially filled with gear lube. The gear lube is thin enough to flow around and between the rollers, lubricating them and helping to prevent overheating of the wheel bearing assemblies. In many rear-wheel drive (RWD) vehicles, the wheel bearing assemblies are open to the axle housing, which is partially filled with

gear lube that also lubricates the differential assembly. Maintenance of this system involves draining the old gear lube and refilling the system with the specified new gear lube. In most cases, this can be performed without disassembling the wheel bearings, by removing a drain plug or bolt and filling the system through the **fill plug** (**FIGURE 8-2**).

A fill plug is usually threaded and can be removed to allow the level of a fluid to be checked and filled. Some manufacturers have chosen to use a rubber fill plug that snaps into the fill hole. The level of gear lube should normally be within 0.25" (6.35 mm) of the bottom of the fill plug hole.

In order to properly perform maintenance on wheel bearings, you need to understand the different characteristics of gear lube and bearing grease. This helps ensure that you select the proper lubricant for the task you are performing. Gear lube is classified by the SAE (Society of Automotive Engineers) according to its viscosity and by the API (American Petroleum Institute) according to its service grade. **Viscosity** refers the thickness of the gear lube; the higher the number, the thicker the gear lube. Vehicle manufacturers specify a certain viscosity of gear lube based on the climate the vehicle is operated in or the load it is carrying, so understanding viscosity is very important when servicing vehicles.

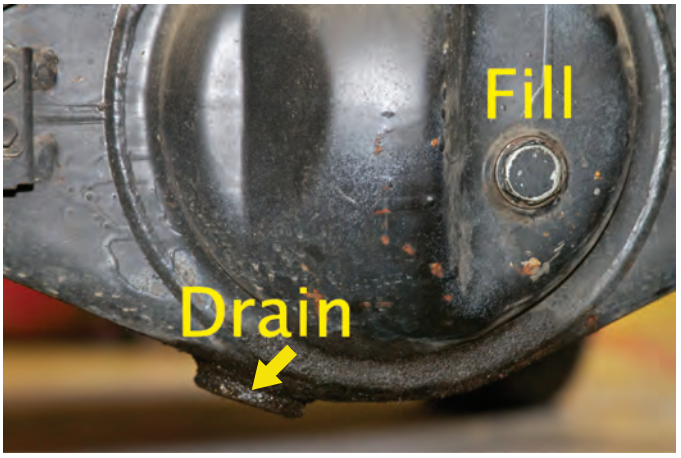



**FIGURE 8-2** Drain and fill points for rear axle assembly.

**▶ TECHNICIAN TIP**

If the level of gear lube is lower than it should be, suspect a leaking axle shaft grease seal. This can usually be verified by looking at the inside of each tire and the backside of the brake backing plate. If gear lube is present, the grease seal is leaking and must be replaced. You should also check the wheel bearing to make sure it is not faulty; to do so, follow the bearing diagnosis procedure listed later in this chapter.

Standard viscosities for gear lube are 70W, 75W, 80W, 85W, 90, and 140. The "W" stands for "winter," or the gear lube's cold temperature viscosity. The non-W ratings are the viscosity of the gear lube at a predetermined hot temperature. Similar to engine oil, gear lube is available in multi-viscosity configurations such as 75W–90, 80W–90, or 85–140. Unlike engine oil, the temperature for the W rating varies according to the standard being met. For example, 70W has a maximum allowable temperature for its viscosity of –67°F (–55°C), while 85W is –10°F (–23°C). The manufacturers have gone to great lengths to specify the proper gear lube for their vehicles. Make sure you follow their recommendations when choosing the gear lube for a particular vehicle.

Current ratings of the API service grade are GL1, GL4, and GL5. Generally, the higher the number, the better the lubricant. GL1 has minimal additives, which makes it unsuitable for modern applications, although it is still used in some heavy truck manual transmissions. GL4 is intended for use with bevel type gears operating under moderate speeds and loads, such as in many manual transmissions. GL5 has about twice as much extreme pressure additive as GL4, so it is intended for most differentials that use hypoid-type gears operating under high-speed/low-speed, high-torque, and shock load conditions. It can also be used in some manual transmissions. Always check the manufacturer's specifications to determine the proper gear lube for the application you are working on.

## Bearing Greases

The OEM (original equipment manufacturer) of the bearing or vehicle will specify the type and consistency of grease for each bearing application. Most serviceable wheel bearings require grease as their lubricant. **Grease** is made of a base oil plus a thickening agent and specific additives to meet the requirements of the application. **Lithium soap** is a common thickening agent in automotive grease. Other greases use calcium or **molybdenum thickening agents**. Some add small amounts of copper and/or lead to enhance the grease's ability to withstand extreme pressures like high loads. Sulfurized fatty oil or chlorine can also be used as EP (extreme pressure) additives.

Automotive wheel bearing grease is a thickened lubricant, designated as a plastic solid. This means that although it is thick enough at room temperature to maintain its shape if left undisturbed, it is thin enough to be squeezed into and out of small spaces. Its consistency is similar to a glob of gel toothpaste. Many greases or lubricants use a dye to provide product identification and give the grease a consistent color. For example, the grease in a constant-velocity joint is green. Grease may also contain a solid such as graphite or molybdenum disulfide (moly), which acts as an antiseize additive.

**TABLE 8-1** NLGI Numbers

| NLGI Number | Relative Consistency |
|---|---|
| 000 | Very fluid |
| 00 | Fluid |
| 0 | Semifluid |
| 1 | Very soft |
| 2 | Soft (typically used for wheel bearings) |
| 3 | Semifirm |
| 4 | Firm |
| 5 | Very firm |
| 6 | Hard |

The **NLGI (National Lubricating Grease Institute)** uses a special test to assign the grease a number. Low numbers are very fluid, and higher numbers are thick, firm, or hard. The thickness of grease as graded by the National Lubricating Grease Institute (NLGI) is listed in **TABLE 8-1**.

Because it does not flow at room temperature, the grease must be packed into the spaces around the rollers when the wheel bearing assemblies are installed. This also has to be done when the grease wears out and must be replaced. Packing a wheel bearing assembly can be done by hand or with a **bearing packer**, which is a tool that forces grease into the spaces between the bearing rollers. Packing a bearing assembly should be done only after thoroughly cleaning and inspecting the rollers and races for wear, damage, or corrosion. If any of these are present, the bearing assembly should be replaced.

Grease is also classified according to quality. Wheel bearing classifications include the following:

- GA—mild duty
- GB—moderate duty
- GC—severe duty, high temperature (frequent stop-and-go service)

GC represents the highest quality grease or lubricant. Chassis grease (if still used with today's sealed joints) is used to lubricate steering and suspension components and includes:

- LA—mild duty (frequent relubrication)
- LB—high loads (infrequent relubrication)

LB indicates the highest quality. Most multipurpose greases are labeled with both wheel bearing and chassis grease classifications, such as GC-LB.

# ▶ Wheel Bearing Types

## Wheel Bearing Overview

Wheel bearings commonly are the following types: cylindrical roller bearing, tapered roller bearing, ball bearing, double-row ball bearings, and double-row tapered roller bearings. Each one is designed for a particular application. For example, roller bearings support the load over a larger surface area, so they can carry heavier loads than ball bearings. The OEM determines the type of wheel bearing they will use, based on the particular application and its requirements. You have to be familiar with each type of wheel bearing to successfully service a variety of vehicles.

## Cylindrical Roller Bearings

**K08005** Describe how side load (thrust) impacts bearing selection.

**Cylindrical roller bearing assemblies** use rollers that are cylindrical or round in shape, so the races are parallel to one another with the rollers between them (**FIGURE 8-3**). This type of wheel bearing assembly is used in situations where the wheel bearing is not subject to side loads. It is common in rear axles of RWD vehicles, where the rear axles are held from moving side to side by means other than the wheel bearings, such as a differential assembly that uses thrust bearings to prevent the axle from moving side to side. Because all side-to-side movement is controlled within the differential assembly, the cylindrical roller bearing assemblies solely support the vehicle's weight. The vehicle's weight provides the bearing load. Some of the axles are retained in the differential housing by what is called a "C" lock that looks like the letter C, which goes around the end of the axles and recesses in the side gear, and held in by the differential pinion pin (**FIGURE 8-4**).

In many cases, cylindrical roller bearing assemblies use the surface of the axle as the inner bearing race. The cylindrical roller bearings ride directly on the axle shaft. In this situation, if the cylindrical roller bearing assembly fails, the axle shaft most likely will have to be replaced, along with the bearing assembly. Some bearing manufacturers have designed replacement cylindrical roller bearing assemblies that ride farther out on the axle shaft than the original bearing, so the axle may not need to be replaced in this situation.

Cylindrical roller bearing assemblies are manufactured to have the proper running clearance between the rollers and races, so no adjustment of this type of wheel bearing

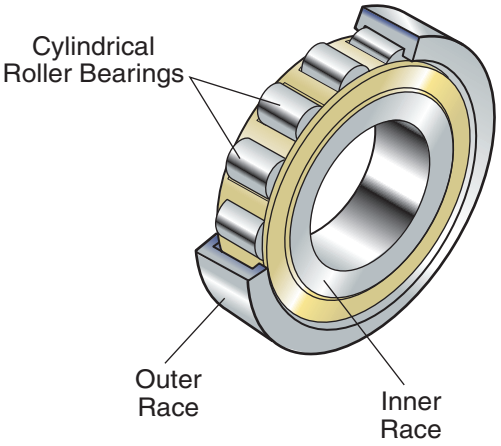



**FIGURE 8-3** Cylindrical roller bearings.

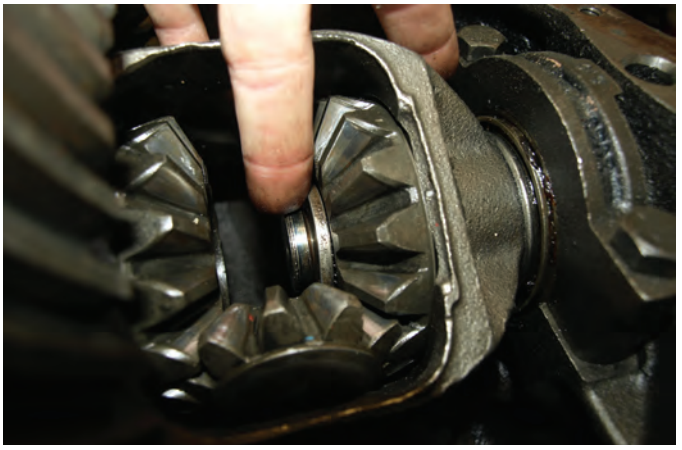


**FIGURE 8-4** C-lock differential axle retention.

is needed. However, they do require lubrication to cushion the rollers and races while operating. Lubrication also removes the heat generated between the rolling surfaces and transmits it to the housing and ultimately the atmosphere. This transfer of heat is usually accomplished by the **gear lube**, which is filled high enough in the differential housing to flow outward to the cylindrical roller bearings. The gear lube is retained in the housing by a **grease seal**, which is located in the outer end of the axle housing outside of the cylindrical roller bearing assembly. This arrangement allows the cylindrical roller bearing assembly to be lubricated while still retaining the gear lube in the housing. At the same time, any dirt and contaminants are sealed out of the housing.


**FIGURE 8-5** Needle bearings used in Cardon U-joint.

## Needle Bearings

A **needle roller bearing** is a bearing which uses small round rollers shaped like pins or needles. The difference between a needle roller bearing and roller bearing is the ratio of diameter and length of their rollers. When the ratio of the diameter and length of the roller in a roller bearing is between the ratios of 0.1:1 and 0.4:1, that roller bearing is called a needle roller bearing. Needle bearings are used to reduce the friction of a rotating surface, mainly in steering components and transmission. Needle bearings are used as engine valvetrain rocker arm pivots and in power steering pumps, air conditioning compressors, and manual/automatic transmissions. The drive shaft of a RWD vehicle typically has at least eight needle bearings (four in each Cardon U-joint, **FIGURE 8-5**). You will not find them used as wheel bearings because of their low load capacity.

Compared to ball bearings, needle bearings use a large surface area that is in contact with the bearing outer surfaces. Additionally there is less added clearance (difference between the diameter of the shaft and the diameter of the bearing), so they are much more compact. The typical structure consists of a needle cage usually made out of a plastic or carbon material, which orients and contains the needle rollers and an outer race.

Radial needle bearings are cylindrical and use rollers parallel to the axis of the shaft. Thrust needle bearings are flat and use a radial pattern of needles and look like a thrust washer.

## Tapered Roller Bearings

**Tapered roller bearing assemblies** are commonly used where heavier loads need to be supported, and the wheel bearings are put under a side load (thrust) condition (Figure 8-5). Wheel bearing side load conditions occur when the vehicle is cornering.

**K08008** Describe the purpose of grease seals.

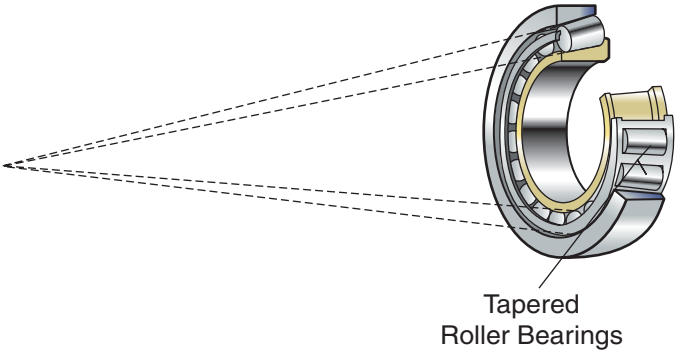



**FIGURE 8-6** With tapered roller bearings, the common axis of bearings and races provides minimal rolling resistance.

When the wheel is being turned, the vehicle wants to keep going straight. This causes the bottom of the outside wheel to be pushed inward and the bottom of the inside wheel outward, which puts them both under a side load condition. In this situation, cylindrical roller bearing assemblies would just allow the wheel to slide sideways on the axle, which means they cannot control the side load (thrust) condition. However, tapered roller bearing assemblies can control the side load or thrust.

With tapered roller bearing assemblies, the races and rollers are tapered in such a manner that all of the tapered angles meet together at a common point (**FIGURE 8-6**). This design allows the tapered rollers to freely roll between the angled inner and outer races. The tapered rollers are contained in a bearing cage, which holds the tapered bearings to the inner race as a unit. The inner race is called the cone. The outer race is called the cup. The cone and cup make up a tapered roller bearing assembly.

Because the components are on an angle to the centerline of (and not parallel to) the axle shaft, they can control side movement (thrust) in one direction unlike a cylindrical roller bearing assembly. Tapered roller bearing assemblies are generally used in opposing pairs so they can control side movement (thrust) in both an inward and outward direction. When used in pairs, the individual tapered roller bearing assemblies are generally referred to as inner (or inboard) and outer (or outboard) bearings. The inner bearing assembly is closer to the centerline of the wheel, so it supports most of the vehicle weight. Because of this, the inner bearing assembly is typically larger than the outer bearing assembly.

Some OEMs have designed double-row tapered roller bearing assemblies, which combine two opposing tapered roller bearing assemblies into one unit. This design provides excellent side thrust–carrying capacity and at the same time excellent load-carrying capacity. For more information on this design, which is used for front and rear sealed wheel bearings, see the section on Sealed Wheel Bearings in this chapter.

Because tapered roller bearing assemblies use tapered components, the wheel bearing assembly must be adjusted to have the proper running clearance between the tapered rollers and races when the bearing assemblies are installed. The **running clearance** is the amount of space between components during operation. If the tapered roller bearing clearance is too tight, the components will bind and overheat due to increased pressure and because the rollers squeeze out too much grease, making the lubricating film too thin. If the tapered roller bearing is adjusted with too much clearance, excessive side-to-side and up-and-down movement will occur, which can cause the components to hammer against one another, damaging the surfaces of the tapered roller bearings and races.

Lubrication of serviceable tapered wheel bearing assemblies is usually accomplished in one of two ways: wheel bearing grease or gear lube. If wheel bearing grease is specified, the tapered wheel bearing will need to be packed with new grease before installing it, as the grease is very thick and does not flow unless it is heated up. When you pack a bearing, you completely fill the spaces between the rollers and races with grease. Packing is best performed with a bearing packing tool, but it can be successfully performed by hand; it just takes a bit longer. This grease, plus a small reserve amount, provides lubrication for the tapered wheel bearing assembly as it is in service. For detailed information on this procedure, see the Wheel Bearing Maintenance and Repair section in this chapter.

Some tapered wheel bearing assemblies are lubricated with gear lube from the axle housing just like the cylindrical bearing assemblies. They do not need to be packed because gear lube flows relatively easily and fills the spaces once the proper amount of gear lube is added to the axle housing. Keeping the gear lube at the proper level is critical for long life of a tapered wheel bearing assembly. If the gear lube gets too low, the tapered wheel bearing assemblies will be starved for lubrication and will overheat, becoming damaged.

Some front axle housings on FWD (four-wheel drive) vehicles use separate, sealed bearing chambers to hold a quantity of gear lube. In either type of system, grease seals help retain the gear lube in the system as well as seal out contaminants.

## Ball Bearings

Deeply grooved ball bearing assemblies are used as wheel bearings on a lot of light-duty vehicles because they have a lower rolling resistance. The much smaller contact area between the balls and races prevents a ball bearing assembly from being used on larger vehicles, which experience higher loads. Ball bearing assemblies consist of an inner race, an outer race, ball bearings, and a ball bearing cage. The balls roll in deep channels in the races. Side loads are controlled by the balls rolling against the sides of the channels. Because there is much less surface area between the balls and the sides of the channels compared to the tapered roller bearing, ball bearing assemblies are limited in how much side load they can handle. At the same time, the small surface area allows them to roll more freely than roller bearings, and they therefore help OEMs decrease drag on a vehicle, which increases fuel efficiency. Ball bearing assemblies depend on lubricants similar to roller bearings; but in most cases, they are usually designed as a sealed bearing assembly. This means that the proper type and amount of lubrication is sealed inside the ball bearing assembly by the OEM and never needs routine maintenance or packing. But if ball bearings become worn or faulty, they must be replaced. This is covered in Skill Drill 8-7 later in this chapter.

Ball bearing assemblies also come in a **double-row ball bearing** assembly (**FIGURE 8-7**). The double-row configuration gives the ball bearing assembly twice the surface contact area, so it can control greater amounts of loads and side loads than a single row bearing assembly. Virtually all wheel bearings using a ball bearing assembly are the double-row ball bearing variety, and they are commonly used in automotive light vehicle applications.

The outer race is usually a one-piece unit, and the inner race is usually two separate pieces. The inner races are manufactured to create the correct running clearance when the double-row ball bearing assembly is torqued in place. In automotive wheel bearing applications, the double-row ball bearing assembly may come as a **unitized wheel bearing hub**, with the bearing assembly installed in the hub and the wheel flange installed in the center of the bearing assembly (**FIGURE 8-8**). In this way, the old ball bearing assembly can be unbolted, and a new one bolted in its place with minimal labor and no adjustments needed. This is virtually a zero maintenance system until it wears out, and then it is usually replaced as a unit.

**▶ TECHNICIAN TIP**

Ball bearings roll more easily than roller bearings because they have a smaller contact area; thus, they provide a small increase in vehicle efficiency.

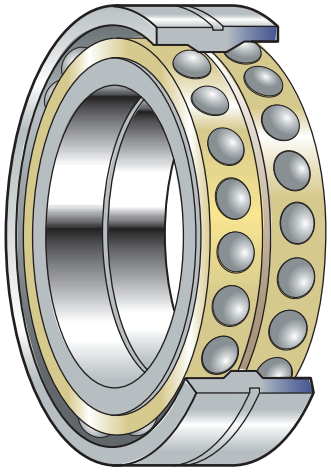


**FIGURE 8-7** Double-row ball bearing assembly.

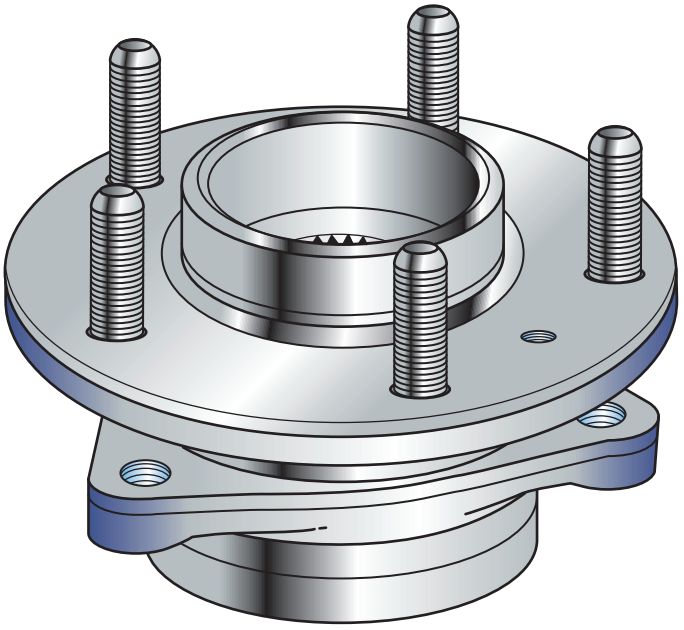


**FIGURE 8-8** Unitized wheel bearing hub assembly.

**FIGURE 8-9** Components of a typical seal.

## Seals and Axle Seals

All wheel bearings rely on some sort of seal to keep the lubricant in and contaminants such as water and dirt out. Some wheel bearings have the seal built right into the bearing assembly, such as the sealed bearings that are covered in detail in this chapter. Other wheel bearings rely on a completely separate grease seal. Wheel bearing grease seals seal against a rotating surface so that lubricants cannot leak from the bearing side of the seal past the shaft to the other side of the seal. They also prevent any dirt and contaminants from getting past the seal into the bearing. In some applications, the grease seal is press fit into the axle housing, which is stationary, and seals against the axle shaft, which is rotating. In other applications, the grease seal is press fit into the wheel hub, which rotates, and seals against the spindle, which does not rotate.

Most axle seals consist of a stamped sheet metal case and flexible sealing lip with an internal **garter spring** (**FIGURE 8-9**). The metal seal case is constructed to be a press fit when installed in the housing. The outside surface of the metal case usually comes pre-coated with a thin layer of sealer compound to seal minor surface imperfections between the seal case and the housing. The sealing lip is carefully designed and precisely manufactured so that it will seal the specified lubricant. Many seals use a garter spring to help hold the lips of the seal in contact with the shaft it is sealing. The garter spring helps maintain an adequate seal if the parts are slightly out of alignment or if there is a small amount of runout or clearance between the seal and shaft.

Seals come in a variety of configurations, so it is critical to use the specified seal for the application you are servicing. The sealing lip is also made from a variety of materials. Always purchase seals from a reputable supplier, so you can be confident the seal will work for your application. When you install a seal, always remember to pre-lube the sealing lip with a small amount of oil or grease. This prevents it from overheating during the initial use, resulting in premature failure of the seal.

**▶ TECHNICIAN TIP**

Grease seals are designed to be used only one time. If you have to remove a seal for any reason, replace it with a new one. Failure to do so will likely result in a leaky seal. Also, if you damage a seal during installation, you should replace it with a new one. Always use care when installing seals, and use the correct installation tool.

**K08006** Describe the purpose of double-row wheel bearings.

**K08007** Describe a unitized wheel bearing hub.

## Sealed Wheel Bearings

Some vehicles use sealed wheel bearings (**FIGURE 8-10**). These bearing assemblies are designed and manufactured as completely sealed units. They can be single row or double row, depending on the vehicle application, and can be made up of ball, cylindrical roller, or tapered roller types of bearings. The bearing assemblies are prefilled with lubricant and have integrated grease seals built into them to contain the lubricant. They also are manufactured with the proper running clearance, so they do not need to be adjusted. This saves the vehicle OEM money by decreasing the time it takes to install them during vehicle assembly. It also makes for a more reliable and consistent installation process as every unit comes preset at the proper clearance. This style of wheel bearing assembly is also beneficial to vehicle owners because it is designed to last the life of the vehicle during normal use and does not need periodic maintenance, which saves owners money.

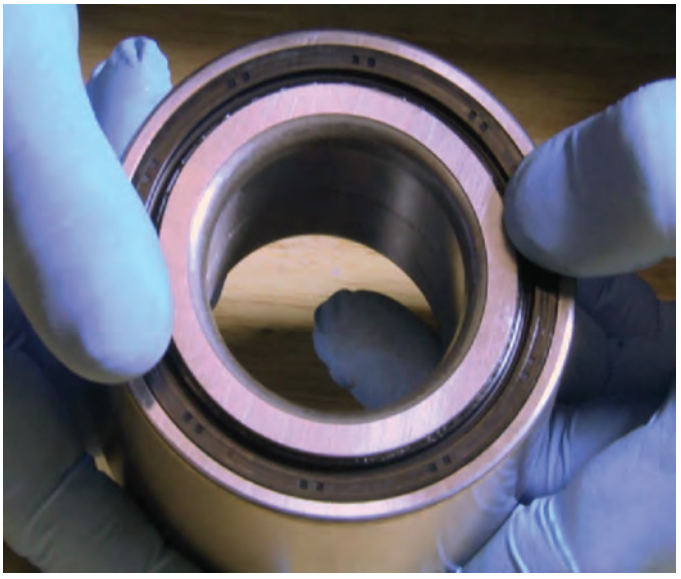


**FIGURE 8-10** A sealed double-row wheel bearing assembly.

Another application for sealed wheel bearings is unitized wheel bearing hubs. These usually include either a double-row ball bearing assembly or a double-row tapered roller bearing assembly installed in a housing that is bolted onto the knuckle or axle housing. In many cases, it also has the wheel flange pressed into the inner race of the wheel bearing. This unit can easily be unbolted from the suspension and replaced as a unit—bearing, hub, and flange. Unitized wheel bearing hubs also provide the benefits offered by the sealed wheel bearing, so manufacturers have embraced them for many of their vehicles. On some vehicles equipped with ABS brakes, the ABS sensor is integrated into the unitized wheel bearing assembly (**FIGURE 8-11**).

## Wheel Speed Sensors

Wheel speed sensors create electrical signals based on the rotational speed of each wheel they monitor. Wheel speed sensors do so by using principles of electromagnetism to generate an analog or digital electrical signal. This signal is read by the EBCM (electronic brake control module) to determine the speed as well as the rate of deceleration of each wheel. This information is used to determine whether a wheel is starting to lock up and skid. A wheel sensor assembly consists of a toothed tone wheel (or tone ring) that rotates with the wheels and a stationary pickup assembly attached to the hub or axle housing. The pickup assembly and tone wheel do not touch each other; a small gap, called an air gap, must be maintained at the specified clearance. Because there is no mechanical connection, there is virtually no wear unless a foreign object gets between them. As each tooth of the tone wheel approaches the pickup, a small voltage is generated. When a sealed wheel bearing is replaced, you generally have to remove wheel speed sensor as part of the repair, and an adjustment may be required (**FIGURE 8-11**).

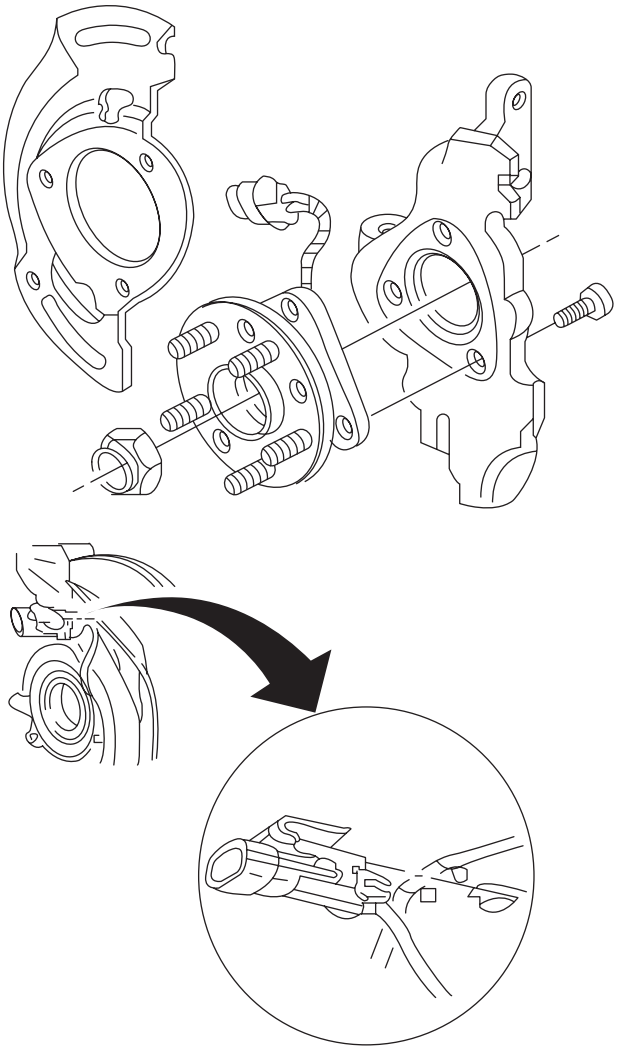


**FIGURE 8-11** Sealed bearing with ABS sensor.

## Wheel Bearing Arrangements for Rear Drive Axles

Rear drive axles come in three different designations: full floating, semi-floating, and ¾ floating. Each designation refers to how the axle and wheel are supported by the wheel bearings. It is also important for you to understand the differences so that you will be able to service each style properly. In a full floating axle arrangement (**FIGURE 8-12**), the axle only carries a twisting force. The weight of the vehicle is fully carried by a pair of tapered roller bearing assemblies, which ride between the hub and axle tube. The axle does not carry any of the vehicle load, as the wheel is bolted directly to the bearing hub. The hub also controls side thrust. Full floating axles handle heavy loads better than the other styles, so they are used in heavy-duty applications such as one-ton pickups, trucks, and vans.

In a semi-floating axle (**FIGURE 8-13**), the wheel flange is part of the axle, which is supported by a single bearing assembly (usually a ball or cylindrical roller bearing style) near the flange end of the axle. The bearing assembly rides between the axle and the axle tube, so all of the weight is put on the axle flange, which transfers the weight to the wheel bearing assembly. In this case, the axle and bearing assembly each carry the full weight of the vehicle. The axle also provides the twisting force for the wheel. This arrangement is generally considered the lightest duty of the three types of axle designations.

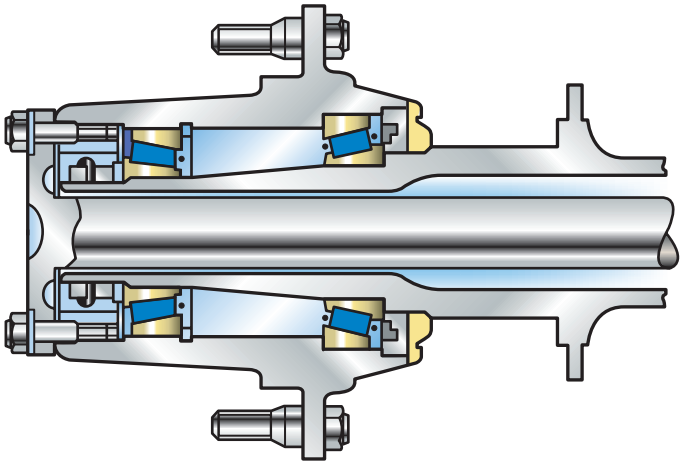


**FIGURE 8-12** Full floating axle.

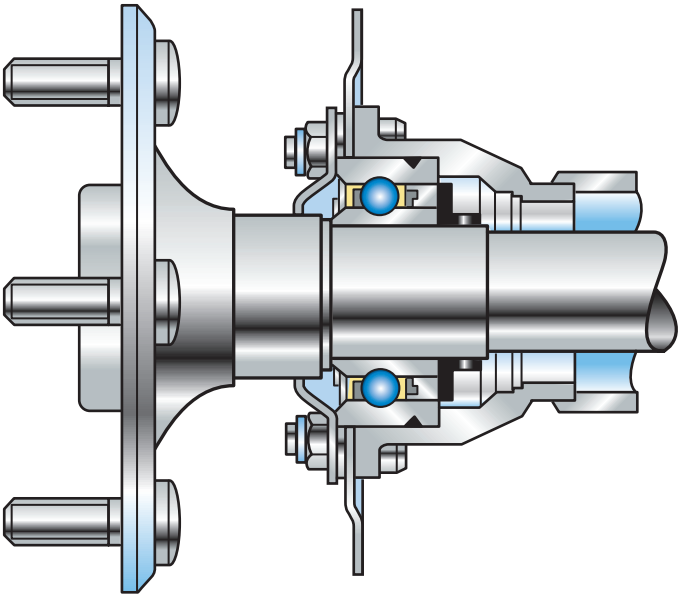


**FIGURE 8-13** Semi-floating axle.


**FIGURE 8-14** ¾ floating axle design axle.

In a ¾ floating axle design (**FIGURE 8-14**), there is a single bearing assembly (usually a ball or cylindrical roller bearing style) between the outside of the axle tube and the hub. The axle has a wheel flange that bolts to the hub and provides lateral support for the hub and wheel while the bearing assembly supports the weight of the vehicle. The axle also provides the twisting force for the wheel. This arrangement is generally considered heavier duty than the semi-floating axle, but lighter duty than the full floating axle.

# ▶ Wheel Bearing Maintenance and Repair

## Overview of Wheel Bearing Maintenance

### Wheel Bearing Tools

Here is a list of common tools used to maintain and repair wheel bearings (**FIGURE 8-15**):

- Bearing grease packer
- Seal puller
- Wheel bearing race installer/seal installer set
- Wheel bearing locknut sockets
- Cotter pin removal tool
- Dust cap pliers

Although sealed wheel bearings are used on a higher percentage of vehicles and require no maintenance, serviceable wheel bearings do require periodic maintenance. Maintenance consists of disassembling, cleaning, inspecting, repacking, installing, and adjusting the bearings. This is commonly performed during brake shoe/pad replacement or at intervals specified by the vehicle OEM, usually at around 24,000–30,000 miles (38,624–48,280 km). A normal part of servicing wheel bearings includes the replacement of the old grease seals with new ones, along with replacement of the cotter pin (if used), which retains the wheel bearing adjusting nut. A **cotter pin** is a soft metal pin that can be bent into shape and is used to retain the bearing adjusting nut. Ensure that the correct replacement parts and grease are available before starting the job.

## Wheel Speed Sensor Cautions

When servicing all late-model vehicles with ABS (antilock brake systems), make sure you disconnect the wheel speed sensor and adjust it, per the online service information, if required.

## Wheel Bearing Lubrication

### Packing Grease with a Bearing Packer

**N08002** Remove, clean, inspect, repack, and install wheel bearings; replace seals; install hub and adjust bearings.

**N08005** Remove, inspect, service and/or replace front and rear wheel bearings.

**S08001** Pack wheel bearings using a bearing packer.

Serviceable wheel bearings should be serviced periodically according to the OEM scheduled maintenance chart, whenever brake work is being performed, or if a faulty wheel bearing is suspected. When servicing wheel bearings, it is critical that the proper grease is used. Also avoid mixing different types of grease by thoroughly cleaning all old grease from the wheel bearings. Another option is to use a bearing packer, with the same kind of grease, to force the old grease out of the wheel bearings (**FIGURE 8-16**). Make sure the grease in the bearing packer is not contaminated with dirt or debris and is correct for the vehicle being serviced.

When reinstalling wheel bearings, it is critical to follow the manufacturer's adjustment procedure. Always use new grease seals and cotter pins (if used). Doing so prevents grease leaks and ensures that the adjusting nut does not back off, causing an unsafe driving situation.

To remove, clean, inspect, repack, and install wheel bearings, and to install the locking mechanism, follow the steps in **SKILL DRILL 8-1**.


**FIGURE 8-15** Wheel bearing maintenance tools.

**FIGURE 8-16** Wheel bearing packing tool.

## SKILL DRILL 8-1 Removing and Repacking Wheel Bearings Using a Packing Tool

**1.** Remove the wheel bearing dust cap with dust cap pliers or a narrow cold chisel and hammer.

**2.** Remove the locking mechanism. The locking mechanism could incorporate one of the following: a cotter pin, a cotter pin and locking cage, a bent locking washer that needs to be straightened, or a locknut that is tightened firmly against the adjusting nut to lock them both in place.

**3.** Remove the adjusting nut, keyed washer, and outer bearing.

**4.** Reinstall the adjusting nut approximately five turns back onto the spindle.

**5.** Grasp the drum/rotor at the 1 o'clock and 7 o'clock positions or 11 o'clock and 5 o'clock positions. While holding downward pressure, quickly pull the drum/rotor toward you. The adjusting nut should catch the inner bearing race and pop the grease seal and bearing out of the hub, leaving them sitting on the spindle. Be careful to not smash your fingers on the spindle while pulling the drum/rotor toward you.

*Continued*

**6.** Use a rag to wipe any old grease off the wheel bearings, races, and spindle, and give them a quick visual inspection for damage. If there is any visible damage, consult the bearing diagnosis chart in this chapter to identify any faults.

**7.** If the wheel bearings appear to be in serviceable condition, completely clean the wheel bearings, races, and hub of all old grease and any contaminants. If using solvent to clean any of the components, make sure there is no solvent-contaminated grease left on the parts, because it will reduce the effectiveness of the lubricant.

**8.** At this point, give the wheel bearings a final thorough inspection, and consult the bearing diagnosis chart in this chapter to identify any faults; then pack both wheel bearings, being careful to keep dirt and debris out of the grease.

To pack grease with a bearing packer like the one in **FIGURE 8-17**, follow the steps:

**9.** Make sure the bearing packer has the proper grease and that it is uncontaminated.

**10.** Place the wheel bearing with the narrow side down. Place the packer cone on the top of the wheel bearing.

**11.** Pack the wheel bearing following the packer's instructions.

**12.** Remove the wheel bearing. Wipe off any old grease.

**13.** Smear some new grease around the outside of the wheel bearing.

**14.** Repeat this process on the other wheel bearing. Be careful not to set a packed wheel bearing down on a dirty surface.

## Packing Grease by Hand

**S08002** Pack wheel bearings by hand.

To pack grease by hand, follow the steps in **SKILL DRILL 8-2**.

### SKILL DRILL 8-2 Repacking Wheel Bearings by Hand

**1.** Using a pair of latex or nitrile (nitro) gloves, place a small glob of grease in the palm of your nondominant hand.

**2.** Place the index finger of your other hand through the bearing center hole, with the larger diameter facing down.

**3.** Push the large diameter of the bearing down the edge of the grease into your palm. This should force grease into the space between the bearings and races.

**4.** Continue this process until grease comes out of the top of the bearing.

**5.** Carefully turn the bearing as a unit to a new space, and keep forcing grease between the bearings. Do this until all of the spaces are full.

*Continued*

**6.** Smear some grease around the outside of the bearing. Repeat this process on the other bearing.

## Installing Wheel Bearings

To install wheel bearings, follow the steps in **SKILL DRILL 8-3**.

**K08010** Describe wheel bearing end play and preload.

**S08003** Install wheel bearings.

### SKILL DRILL 8-3 Installing Wheel Bearings

**1.** Place a small amount of extra grease in the center of the hub. Do not fill it completely. Some technicians say to only smear a thin layer all the way around the inside of the hub to prevent the surface from rusting. Other technicians say to only place enough inside of the hub to bring it level with the bearing races. Either way, not very much grease is needed to keep the bearings lubricated, so go easy on the amount of grease you place in the hub.

**2.** Place the inner wheel bearing in its race, narrow side toward the race.

**3.** Install the new grease seal, being careful not to damage it. The use of a seal driver is best, but many seals can be installed with just a hammer if you are careful to keep it straight as it is being installed. Place a small amount of grease on the lip of the seal to provide it with initial lubrication.

**4.** Without getting grease on the drum/rotor, carefully install the bearing on the spindle, making sure the inner bearing fully seats against the spindle flange.

*Continued*

**5.** Install the outer bearing on the spindle and into the race.

**6.** Install the keyed washer and adjusting nut on the spindle, and tighten until finger tight.

**7.** Tighten the adjusting nut to the specified seating torque (usually about 20 ft-lb [27.1] N·m) while turning the drum/rotor. This squeezes the excess grease out from between the wheel bearings and races while seating the bearings.

▶ NOTE

Do *not* leave the bearing this tight, as it is too tight for operation of the vehicle. Make sure you perform the next step!

**8.** Loosen the adjusting nut approximately one-sixth to one-quarter turn without turning the drum/rotor, and then tighten the adjusting nut to the specified preload torque. This is usually about 15–25 in-lb (1.69–2.82 N·m).

▶ NOTE

The unit is inch-pounds, *not* foot-pounds. Don't mistake the two!

**S08004** Install the locking mechanism on a wheel bearing.

**K08010** Describe wheel bearing end play and preload.

▶ TECHNICIAN TIP

Some technicians simulate the preload torque by placing a 12" crescent wrench on the nut and using the hanging weight of the crescent wrench when it is parallel to the ground. Do not let it drop into position; just lower the handle to where it stops turning the nut. This should be when the handle is approximately level. If not, reposition the crescent wrench on the nut and allow it to lower until it stops parallel.

## Installing the Locking Mechanism

To install the locking mechanism, follow the steps in **SKILL DRILL 8-4**.

## Wheel Bearing Adjustment

All wheel bearings need the proper end play or preload to operate correctly. **End play**, in the context of wheel bearings, refers to the amount of inward and outward movement of the hub due to the clearance within the bearing assembly. **Preload** refers to the absence of clearance in the bearing and the specified amount of pressure forcing the bearing components together. Sealed bearings and double-row bearing assemblies come, from the bearing manufacturer, with the proper clearance machined into them. These wheel bearings are designed so that when the components are tightened together, the races butt up against in such a way that the proper clearance is maintained. For these wheel bearings, it is only critical that the retaining bolt or bolts are torqued to the proper torque specification. This is usually quite high and can typically exceed 200 ft-lb or 271 N·m. Be sure to check the OEM torque specifications for the vehicle you are working on.

On adjustable wheel bearings, the proper clearance must be set using the adjusting nut. In this case, the adjusting nut is only tightened lightly so that a small amount of clearance or

## SKILL DRILL 8-4 Installing the Locking Mechanism

**1.** Install the locking mechanism.

**2.** If it is a cotter pin, insert the new cotter pin through the **castellated nut** or locking cage and spindle (the spindle may have more than one hole). The short leg of the cotter pin should be against the castellated nut, and the long leg should be toward you. With the cotter pin fully engaged in the notch, bend the outer leg toward you and up over the end of the spindle. Cut it off just short of the spindle. Also cut the short leg off so it does not extend beyond the nut or cage. Make sure the cotter pin will not hit the inside of the dust cap.

**3.** If it is a bendable tang locking style, then place the tang washer against the adjusting nut, and thread the locking nut up against it. Torque the locking nut to the specified torque, and bend the appropriate tang out toward you against the flat side of the locking nut with a small pry bar to lock the adjustment in place.

**4.** If it is a locking nut style, then tighten the locknut to the specified torque. This is usually a substantial torque of 50 ft-lb (67.79 N·m) or more.

**5.** Install the dust cap, being sure it is fully seated in the hub. Make sure the drum/rotor turns freely without binding or making any unusual noises.

preload is maintained between the rollers and races, depending on the OEM specifications. The **adjusting nut** is then locked in place by a locking mechanism so that it cannot loosen. This is critical to prevent the wheel from falling off and causing injury or vehicle damage.

The most common locking mechanism uses a **keyed washer** (hardened), adjusting nut, **lock cage**, and cotter pin, as shown in **FIGURE 8-17**. On FWD vehicles, the locking mechanism commonly includes a keyed washer (hardened), adjusting nut, **keyed lock washer** (or tang washer), and **locknut** (**FIGURE 8-18**). To learn more about the procedure, see Skill Drill 8-4.

## Replacing Wheel Bearings and Races

**N08003** Replace wheel bearing and race.

**S08005** Replace a wheel bearing and race.

Wheel bearings and races need to be replaced only when they are damaged. If one part of the wheel bearing is damaged, all parts must be replaced. So if the tapered roller bearings are damaged, both the bearing and the race of that bearing must be replaced at the same time. On serviceable bearings, the inner race, roller bearings, and bearing cage are one unit, which generally slips off the spindle. The outer race is usually press fit into the hub and has to be driven or pressed out and a new one press fit back in. It is critical that the seat in the hub is spotlessly clean, with no burrs, or the bearing race will not seat properly and the bearing will fail prematurely. To replace a wheel bearing and race, follow the steps in **SKILL DRILL 8-5**.

**FIGURE 8-17** Typical cotter pin–style wheel bearing locking mechanism.

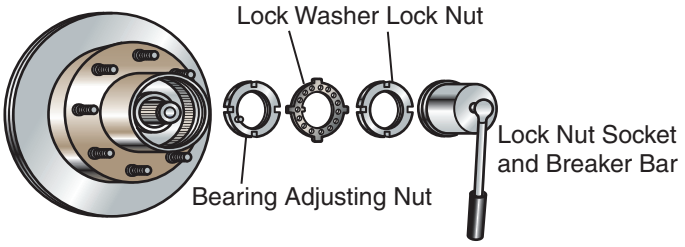



**FIGURE 8-18** Typical locknut–style wheel bearing locking mechanism.

## SKILL DRILL 8-5 Replacing Wheel Bearing and Race

**1.** With the wheel bearings removed from the wheel hub, clean and inspect the bearings and races. If damaged, or if you are directed by your supervisor to do so, determine which race to remove.

**2.** Using a hydraulic press, or a hammer and punch from the opposite side of the hub carefully force the race from the hub. In either case, it is critical that the race be removed as straight as possible to prevent damaging the hub.

*Continued*

**3.** Clean the inside diameter of the hub in a parts washer.

**4.** Remove any burrs with a fine file or Dremel™ tool and remove any debris from the seat.

**5.** Lightly lubricate the outside surface of the new race, and set it thick side down in the hub.

**6.** Using a hydraulic press, or a hammer and bearing race installer, carefully drive the race until it is fully seated in the hub. When using a hammer and punch, a sharp metallic sound should be heard when the race is fully seated, compared to the dull thud as it is being driven into place.

**7.** Inspect the race to verify that it is fully seated. Also check for any damage caused by installation.

**8.** If everything is good, pack the new bearing, and install it according to Skill Drills 8-1 to 8-3.

## Removing and Reinstalling Sealed Wheel Bearings

Sealed wheel bearings come in two configurations. The first is a replaceable sealed bearing only. On most front wheels, this wheel bearing is pressed between the hub and wheel flange and is the more difficult of the two to replace. The second configuration consists of a unitized wheel bearing hub including a sealed wheel bearing, a removable wheel bearing hub, and possibly the wheel flange. In most cases, this type can be unbolted from the suspension system and a new one bolted in its place, and it is ready to go. The replaceable bearing style needs to be pressed apart with a hydraulic press or a special sealed bearing removal/installing tool. If using the hydraulic press method, the steering knuckle has to be removed from the vehicle so it can be placed on the hydraulic press. If the special sealed bearing tool is used, most bearings can be removed while the steering knuckle is still installed on the vehicle, which can save the technician a fair amount of time. To remove and reinstall a sealed wheel bearing assembly using the unitized wheel bearing hub style, follow the steps in **SKILL DRILL 8-6**.

**N08004** Remove, reinstall, and/or replace sealed wheel bearing assembly.

**S08006** Remove and reinstall a sealed wheel bearing using the unitized wheel bearing hub style.

## SKILL DRILL 8-6 Removing and Reinstalling Sealed Wheel Bearings Using the Unitized Wheel Bearing Hub Style

**1.** Loosen the axle hub nut, if equipped, while the tire is still on the ground. This nut could be tightened to 200 ft-b (271.1 N·m) or more, so it is easier to break loose with the tire preventing the axle from spinning while loosening the nut. Some vehicles will require you to remove a locking mechanism such as a cotter pin to remove the axle nut. If the wheel has already been removed, you can lock the rotor with a large screwdriver.

**2.** Remove the wheel and brake assembly following a downloaded procedure. Also disconnect the ABS (antilock brake system) connector and/or sensor if mounted to the hub, so as not to damage the sensor, connector, or wiring.

**3.** If the wheel you are working on is a drive wheel, remove the axle hub nut, and tap the drive axle loose with a dead blow hammer. Be careful not to damage the threads on the end of the axle.

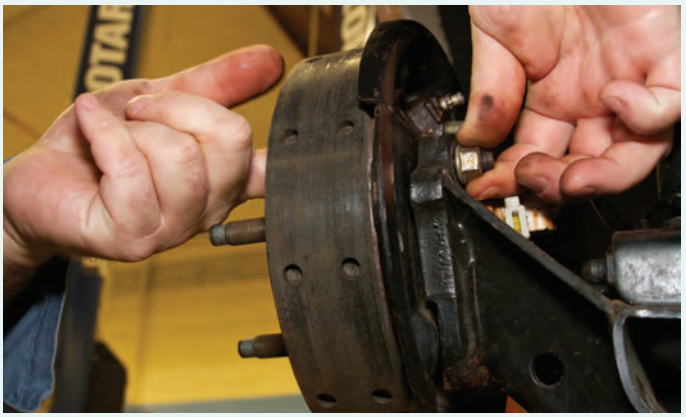
**4.** Unbolt and remove the hub assembly from the steering knuckle, which is usually held on by approximately four bolts.

**5.** Clean the steering knuckle and check the hub seat for nicks, burrs, or other damage.

*Continued*

**6.** Carefully compare the new hub to the old one; then fit the new hub assembly (over the axle shaft, if equipped) to the knuckle, making sure it is fully seated, and torque the mounting bolts to the OEM torque.

**7.** Reassemble the brake assembly and ABS sensor, if removed, following a downloaded online specified procedure; install the wheel; and torque the lug nuts to OEM specifications. Be sure the correct ends of the lug nuts are facing the wheel.



**8.** Install the drive axle nut, if equipped. Use a new hub nut if called for by the manufacturer, and torque to specifications.

# ▶ Diagnosis of Tire and Wheel Bearing Concerns

## Diagnosis Overview

**K08011** Describe the process of diagnosing wheel bearing concerns

**N08001** Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine needed action.

Wheel bearings can be damaged from excessive loads such as overloading the vehicle, shock loads such as hitting a large pot hole, improper adjustment, or just plain wear over time. The wheel bearings must hold up under difficult circumstances, so suspect faulty bearings whenever an unusual rumbling, whirring, howling, or rough sound comes from the wheel areas when the vehicle is being driven. The noise usually can be heard once the vehicle gets up to 15–20 mph (24.1–32.2 kph) and gets louder as the vehicle speeds up.

Loose or worn wheel bearings can also cause the vehicle to wander, shimmy, or vibrate. For these concerns, it is best to lift the wheels off the ground and check the wheel bearings for looseness by grabbing the tire at the 6 o'clock and 12 o'clock positions and lightly wiggling it back and forth. Watch the inside of the wheel to see if the play is coming from the wheel bearings and not the ball joints. Then grab the wheel at the 3 o'clock and 9 o'clock positions and again lightly wiggle the wheel back and forth. Watch to see if the play is coming from the wheel bearings and not the tie rod ends. If there is play in the wheel bearings and the vehicle uses sealed bearings, they will have to be replaced.

If the vehicle uses serviceable bearings, the maximum allowable play is approximately 0.010" (0.254 mm). If greater than that, they will need to be disassembled, cleaned, inspected, repacked, reinstalled, and readjusted if they are still in good condition.

One way to isolate a wheel bearing noise from a transmission noise is to drive the vehicle at the speed at which it is making the noise and then shift into a higher or lower transmission gear while maintaining the same speed. If the noise changes when the vehicle speed goes up or down, then it is a transmission-related issue. If it stays relatively the same, accelerate, coast, and decelerate the vehicle. If the noise changes suspect the

differential or universal joints. If the noise stays relatively steady, it is most likely related to the wheel bearings.

To determine which side the bearing noise is coming from, you can sometimes drive the vehicle at the speed at which it is making the noise and then lightly rock the car side to side using the steering wheel. If the noise gets louder when the car is steered right, then it is usually the left side with the bad bearing, and vice versa. Only perform this test in a safe place such as an abandoned parking lot. Another challenge is distinguishing a wheel bearing noise or a tire noise. The best approach to this problem is to drive over different road surfaces such as asphalt and concrete. If the noise changes, it is likely a tire problem. If the noise does not change, it is likely to be a faulty wheel bearing. If you cannot determine the source of the noise on a road test, you might be able to determine the source of the noise by placing the vehicle on a hoist and rotating the wheels. If the vehicle has a MacPherson strut suspension, raise and support the vehicle and spin the wheel by hand while holding on to the coil spring with the other hand, feeling for a vibration or roughness. The spring tends to magnify the wheel bearing roughness, which can be felt with some practice. If the suspect wheel is a drive wheel, have an assistant drive the vehicle in gear while on the hoist, and listen to the wheel bearings with a stethoscope.

**▶ CAUTION**

Because the vehicle is running on the hoist, this can be a hazardous situation and must only be performed under the close guidance of your supervisor along with another technician present.

## Wheel Bearing Failure Analysis

Wheel bearings can be inspected and determinations made about why the wheel bearing failed. Getting to the source of the problem is important to ensure that the same thing does not happen to the new wheel bearings. Failure analysis starts with removing the faulty wheel bearing and cleaning it and the races thoroughly. Once they are clean, visually inspect the wheel bearing components and compare your findings to the wheel bearing manufacturer's failure analysis chart, which you can download from the online service information for the vehicle you are working on. This information should lead you to what caused the wheel bearing failure.

Once the cause of the wheel bearing failure has been determined, measures must be taken to ensure that the failure does not repeat itself. For example, if the bearing and race surfaces show signs of rust or corrosion, you need to inspect and replace the grease seals along with replacing the wheel bearing assembly. Also, if the wheel bearing is so worn that there are metal shavings in the wheel hub and grease, a thorough cleaning of the wheel hub will be required so that all of the metal shavings are removed and will not ruin the new bearing assembly.

Some wheel bearing failures involve the races spinning in either the machined bore of the wheel hub or on the surface of the spindle/axle. This can lead to wear of the wheel hub or spindle/axle, which requires replacement of these components. Be sure to inspect the wheel hub and spindle/axle closely for any damage every time the wheel bearings are removed and serviced.

# ▶ Wrap-Up

## Ready for Review

- Wheel bearings allow wheels to roll with minimum friction.
- Wheel bearing assemblies include outer race, inner race, roller or ball bearings, and a bearing cage
- Categories of wheel bearings are serviceable or sealed.
- Types of wheel bearings are cylindrical roller bearing, tapered roller bearing, ball bearing, double-row ball bearing, and double-row tapered roller bearings.
- Cylindrical roller bearing assemblies have parallel races flanking the rollers and are most commonly used in rear axles of rear-wheel drive vehicles.
- Cylindrical roller bearing assemblies rely on lubrication to cushion the rollers and transfer heat to the atmosphere.
- A needle roller bearing is a bearing that uses small round rollers shaped like pins or needles. The difference between a needle roller bearing and roller bearing is the ratio of diameter and length of their rollers.

- Tapered roller bearing assemblies have tapered rollers housed in a bearing cage; they are used in pairs for heavier loads and control side movement.
- Tapered roller bearing assemblies must be adjusted for proper running clearance.
- Ball bearings are used in light-duty vehicles, are designed as a manufacturer sealed bearing assembly, and should be replaced as a unit.
- Wheel bearings are sealed to keep out contaminants and contain the lubricant.
- Serviceable wheel bearings need periodic maintenance, including replacing old grease seals and the cotter pin.
- Wheel bearings are lubricated by gear lube or bearing grease.
- Gear lube is classified by SAE viscosity (thickness) and service grade.
- Bearing grease is graded by thickness; it holds its shape at room temperature and its quality.
- For correct operation, wheel bearings must be adjusted for proper end play preload.
- Wheel bearing locking mechanisms include a keyed washer, adjusting nut, lock cage, and cotter pin.
- Damage to wheel bearings may be from vehicle overload, shock loads, improper adjustment, or wear over time.
- Wheel bearing assembly diagnosis may include wiggling the tire (with vehicle lifted) by hand, by test driving, or placing on a hoist and rotating the wheels.
- If the vehicle uses serviceable bearings, the maximum allowable play is approximately 0.010" (0.254 mm). If greater than that, they will have to be disassembled, cleaned, inspected, repacked, reinstalled, and readjusted if they are still in good condition.
- Determine the cause of wheel bearing failure so that the new bearings are not damaged for the same reason.

## Key Terms

**adjusting nut** The nut used to adjust the end play or preload of a wheel bearing.

**antifriction bearing** Wheel bearing assemblies that use surfaces that are in rolling contact with each other to greatly reduce friction compared to surfaces in sliding contact.

**ball bearings** The rolling components of a wheel bearing, consisting of hardened balls that roll in matching grooves in the inner and outer races.

**bearing cage** The component in a wheel bearing that maintains the proper spacing between the roller bearings or ball bearings.

**bearing packer** A tool that forces grease into the spaces between the bearing rollers.

**bushing** A sleeve-type bearing made of metal or plastic bearing material used to support a rotating shaft.

**castellated nut** An adjusting nut with slots cut into the top such that it resembles a castle; used with a cotter pin to prevent the nut from turning.

**cotter pin** A one-use soft metal pin that can be bent into shape and is used to retain bearing adjusting nuts.

**cylindrical roller bearing assembly** A type of wheel bearing with races and rollers that are cylindrical in shape and roll between inner and outer races, which are parallel to each other.

**double-row ball bearing assembly** A single ball bearing assembly using two rows of ball bearings riding in two channels in the races.

**end play** The in-and-out movement of the hub caused by clearance within the wheel bearing assembly.

**fill plug** Usually a threaded plug that can be removed to allow the level of a fluid to be checked and filled. This could also be a rubber snap fit plug.

**friction bearing** A bearing that uses sliding motion between components, such as a clutch pilot bearing.

**garter spring** A coiled spring that is fitted to the inside of the sealing lip of many seals, used to hold the lip in contact with the shaft.

**gear lube** A type of lubricant primarily used to lubricate transmission and differential gears but also used to lubricate some wheel bearings.

**grease** A lubricating liquid thickened to make it suitable for use with many wheel bearings.

**grease seal** A component that is designed to keep grease from leaking out and contaminants from leaking in.

**inner race** The inside component of a wheel bearing that has a smooth, hardened surface for rollers or balls to ride on.

**interference fit** A condition in which two parts are held together by friction because the outside diameter of the inner component is slightly larger than the inside diameter of the outer component.

**keyed lock washer** The washer that fits between the adjusting nut and the locknut; the face of the washer is drilled with a series of holes that mate to a short pin from the adjusting nut, locking it to the spindle; also referred to as a tang washer.

**keyed washer** The washer that fits between the adjusting nut and the wheel bearing and that has the center hole keyed to fit a slot on the spindle or axle tube.

**lithium soap** A thickening agent for grease to give it the proper consistency.

**lock cage** The stamped sheet metal cap that fits over the bearing adjustment nut and is secured by a cotter pin going through it and the spindle/axle.

**locknut** The nut that holds the adjusting nut from turning; usually tightened much tighter than the adjusting nut.

**molybdenum thickening agent** A compound used in some greases to give it the needed consistency.

**National Lubricating Grease Institute (NLGI)** An organization that grades the thickness of automotive and industrial grease.

**needle roller bearing** A bearing which uses small round rollers shaped like pins or needles. The difference between a needle roller bearing and roller bearing is the ratio of diameter and length of their rollers.

**outer race** The outside component of a wheel bearing that has a smooth, hardened surface for rollers or balls to ride on.

**preload** A condition where the wheel bearing components are forced together under pressure and therefore have no end play.

**roller bearings** The rolling components of a wheel bearing, consisting of hardened cylindrical or tapered rollers.

**running clearance** The amount of space between wheel bearing components while in operation.

**sealed bearings** Wheel bearings that are assembled by the manufacturer with the proper lubrication and sealed for life; they cannot normally be disassembled.

**serviceable bearings** Wheel bearings that can be disassembled, cleaned, inspected, packed, reinstalled, and adjusted.

**tapered roller bearing assembly** A type of wheel bearing with races and rollers that are tapered in such a manner that all of the tapered angles meet at a common point, which allows them to roll freely and yet control thrust.

**unitized wheel bearing hub** An assembly consisting of the hub, wheel bearing(s), and possibly the wheel flange, which is preassembled and ready to be installed on a vehicle.

**viscosity** The measurement of the thickness of a liquid.

**wheel bearing** A component that allows the wheels to rotate freely while supporting the weight of the vehicle, made up of an inner race, outer race, rollers or balls, and a cage.

## Review Questions

1. Which component of a wheel bearing holds the rollers or balls in place?
   a. An outer race
   b. An inner race
   c. A bearing cage
   d. Interference fit
2. All of the following statements with respect to sealed and serviceable bearings are true, EXCEPT:
   a. Sealed bearing assemblies are prefilled with lubricant and have integrated grease seals unlike serviceable bearings.
   b. In serviceable bearings proper running clearance needs to be adjusted whereas in sealed bearing it is manufactured with clearance.
   c. Sealed bearing assemblies do not need periodic maintenance unlike serviceable bearings.
   d. Sealed bearing assemblies cannot fail at any time, whereas serviceable bearings can fail.
3. Which type of bearing is recommended for a vehicle which is subjected to heavy loads and thrust during turning around the corners?
   a. Wheel bearing
   b. Cylindrical roller bearing
   c. Tapered roller bearing
   d. Ball bearing
4. All of the following statements describing difference between single-row and double-row ball bearings are true, EXCEPT:
   a. Single-row has one inner and outer race whereas double-row bearing has two separate inner and outer races.
   b. Single-row has less surface contact area than double-row.
   c. In double-row bearing, the inner race is usually two separate pieces unlike single-row.
   d. Double-row control greater amounts of loads and side loads than a single-row bearing assembly.
5. In which of the following is the bearing assembly installed in the hub and the wheel flange installed in the center of the bearing assembly?
   a. Normal ball bearing
   b. Unitized ball bearing
   c. Double-row ball bearing
   d. Single row ball bearing
6. Choose the correct statement describing grease seals:
   a. Grease seals cannot keep dirt away.
   b. Grease seals cannot provide sealing against rotating surface.
   c. Grease seals can be re-used and need not be replaced.
   d. Grease seals prevent leakage of lube and prevent dirt and contamination.
7. Bearing greases which are to be employed in extreme pressure use all of the following additives, EXCEPT:
   a. Copper
   b. Chlorine
   c. Lead
   d. Titanium
8. The thickness of the grease is graded and it is assigned a number by the National Lubricating Grease Institute (NLGI). The relative consistency that the NLGI number "4" represents is:
   a. very fluid
   b. soft (typically used for wheel bearings)
   c. firm
   d. very firm
9. Which of the following components should be mandatorily inspected whenever the wheel bearings are removed and serviced?
   a. The wheel hub
   b. Wheel races
   c. Race surface
   d. Bearing assembly
10. In case of serviceable wheel bearings, the maximum allowable play is:
    a. 0.001" (0.025mm).
    b. 0.010" (0.254 mm).
    c. 0.015" (0.381 mm).
    d. 0.020" (0.508 mm).

## ASE Technician A/Technician B Style Questions

1. Tech A says that cylindrical roller bearings can carry more weight than similarly sized ball bearings. Tech B says that tapered roller bearings used in opposing pairs control side thrust. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B

2. Tech A says that a tapered roller bearing assembly has less rolling resistance than a similarly sized ball bearing assembly. Tech B says that the bearing assembly in a unitized wheel bearing assembly can normally be disassembled, cleaned, and repacked. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
3. Tech A says that the garter spring helps maintain an adequate seal if the parts are slightly out of alignment. Tech B says that grease seals need to be replaced every time the bearing is removed. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
4. Tech A says that in a full floating axle, weight of the vehicle is fully carried by a pair of tapered roller bearing assemblies, which ride between the hub and axle tube. Tech B says that when installing tapered wheel bearings, the final torque should be about 50 ft-lbs. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
5. Tech A says that serviceable wheel bearings can be repacked by removing the dust cap, filling it with grease, and reinstalling it. Tech B says that the cotter pin must be replaced with a new one every time it is removed. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
6. Tech A says that the grease level in the final drive is okay as long as you can touch the level with your finger. Tech B says that the grease level should normally be no more than ¼" below the threads on the fill plug hole. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
7. Tech A says that wheel bearings need to be replaced as a set: bearing and race. Tech B says that the wheel bearings and races on both sides of the vehicle must be replaced if one side fails. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
8. Which of these refers the thickness of the gear lube?
   a. Viscosity
   b. NLGI number
   c. Quality number
   d. Specific gravity
9. Two technicians are discussing how to install a replacement tapered front wheel bearing. Tech A says when installing a bearing race you should use a 5 lb hammer and a brass drift. Tech B says that you should use a hydraulic press or a hammer and bearing race installer, carefully drive the race until it is fully seated in the hub. Who is right?
   a. Tech A
   b. Tech B
   c. Both A and B
   d. Neither A nor B
10. Tech A says that when a race is fully seated, a sharp metallic sound will be produced when installation is complete. Tech B says that to be sure a race is fully seated, the wheel bearing adjusting nut should be tightened to at least 100 ft-lbs of torque, which will finish seating it. Who is right?
    a. Tech A
    b. Tech B
    c. Both A and B
    d. Neither A nor B

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## SAMPLE CHAPTER 8

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