Using soapy water from a spray bottle is an easy method to find the location of an air leak from a tire.

This chart shows the relationship between tire inflation pressure and load capacity of the tire.
Figure 111-3  This chart shows that a drop in inflation pressure has a major effect on fuel economy.

![Chart showing fuel economy vs. inflation pressure]

Figure 111-4  Notice that if a tire is underinflated by 10 PSI, the life expectancy is reduced by 40%.

![Chart showing percentage of tire wear life vs. inflation pressure]

Figure 111-5  A temporary inflation pump that uses 12 volts from the cigarette lighter to inflate the tire.

![Diagram of a tire and a temporary inflation pump]
FREQUENTLY ASKED QUESTION: What Is a Temporary Mobility Kit?

A temporary mobility kit is a system to inflate a flat tire supplied by the vehicle manufacturer instead of a spare tire. A temporary mobility kit can include:

- A compressor powered by the cigarette lighter.  
  SEE FIGURE 111–5.
- An aerosol spray can that provides inflation and sealer.  
  SEE FIGURE 111–6.

Either type can be found in many vehicles because tests indicate weight savings, increased trunk space, and cost less than a conventional spare tire and jack. However, these kits are designed to be a temporary repair only because the cause of the low tire was never determined. If the tire appears to be fixed, many vehicle owners may think the tire has been repaired. However, the tire should be carefully inspected inside and out for damage and properly repaired.

Figure 111-6

Many vehicle manufacturers include an aerosol can of sealer on vehicles that are not equipped with a conventional spare tire.

Figure 111-7

Most shops that use nitrogen inflation install a green tire valve cap to let others know that nitrogen, rather than air has been used to inflate the tires.
Figure 111-8  Note the difference in the shape of the rim contour of the 16-in. and 16 1/2-in. diameter wheels. While it is possible to mount a 16-in. tire on a 16 1/2-in. rim, it cannot be inflated enough to seat against the rim flange. If an attempt is made to seat the tire bead by overinflating (over 40 PSI), the tire bead can break, resulting in an explosive force that could cause serious injury or death.

Figure 111-9  When installing a tire-pressure monitoring system sensor, be sure that the flat part of the sensor is parallel to the center section of the rim.

Figure 111-10  This tire on a new vehicle has been match mounted at the factory. The yellow sticker is placed at the largest diameter of the tire. The valve core hole in the wheel is usually drilled at the smallest diameter of the wheel. The best way to make sure the assembly is as round as possible and to reduce the number of wheel weights needed to balance the tire is to align the sticker with the valve core.
Figure 111-11 (a) Cleaning the bead area of an aluminum (alloy) wheel using a handheld wire brush. Some technicians prefer to use the changer itself to rotate the wheel as the brush is used to remove any remnants of the old tire.

Figure 111-11 (b) Using an electric or air-powered wire brush speeds the process, but care should be exercised not to remove any of the aluminum itself. (Remember, steel is harder than aluminum and a steel wire brush could cause recesses to be worn into the aluminum wheel, which would prevent the tire from proper seating in the bead area.) The bead seat area on steel wheels should also be cleaned to prevent air leaks at the rim.

TECH TIP: Spin the Tires
When performing a vehicle inspection and the vehicle has been hoisted on a frame-type lift, check the tires by rotating them by hand. The tires on the nondrive wheels should spin freely.

- On front-wheel-drive vehicles, rear wheels should rotate easily.
- On rear-wheel-drive vehicles, front wheels should rotate easily.
- On all-wheel-drive vehicles, all four wheels may require effort to rotate.

What to Look For:
- When rotating the wheels, look at the tires from the front or rear and check that the tread of the tires does not change or look as if the tread is moving inward or outward. If the tread is moving, this indicates an internal fault with the tire and it should be replaced. This type of fault can cause a vibration even though the tire/wheel assembly has been correctly balanced.
- Look from the side of the vehicle as the wheel/tire assembly is being rotated. Look carefully at the tread of the tire and see if the tire is round. If the tire is out-of-round, the tread will appear to move up and down as the tire is being rotated.
Rendered (odorless) animal fat is recommended by some manufacturers of tire changing equipment for use as a rubber lubricant.

Always tighten wheel lug nuts (or studs) in a star pattern to ensure even pressure on the axle flanges, brake rotors or drums, and the wheel itself.

Most manufacturers recommend using hand tools rather than an air impact wrench to remove and install locktype lug nuts to prevent damage. If either the key or the nut is damaged, the nut may be very difficult to remove.
A torque-limiting adapter (torque stick) for use with an air impact wrench will allow you to control the torque output. The air pressure to the air impact should be limited to 125 PSI (860 kPa) in most cases, and the proper adapter must be selected for the vehicle being serviced. The torque adapter absorbs any torque beyond its designed rating. Most adapters are color-coded for easy identification as to the size of lug nut and torque value.

TECH TIP: Fine-Tune Handling with Tire-Pressure Changes

The handling of a vehicle can be changed by changing tire pressures between the front and rear tires.

Understeer—A term used to describe how a vehicle handles when cornering where additional steering input is needed to maintain the curve, or resisting turning into a corner. This is normal handling for most vehicles.

Oversteer—A term used to describe handling where correction while cornering is often necessary because the rear tires lose traction before the front tires.

<table>
<thead>
<tr>
<th>Tire Pressure</th>
<th>To Decrease</th>
<th>To Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front tire inflation</td>
<td>Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>Rear tire inflation</td>
<td>Decrease</td>
<td>Increase</td>
</tr>
</tbody>
</table>

CAUTION: Do not exceed the maximum inflation pressure as imprinted on the tire sidewall.

REAL WORLD FIX: I Thought the Lug Nuts Were Tight!

Proper wheel nut torque is critical, as one technician discovered when a customer returned complaining of a lot of noise from the right rear wheel. See Figure 111–16 for a photo of what the technician discovered. The lug (wheel) nuts had loosened and ruined the wheel.

CAUTION: Most vehicle manufacturers also specify that the wheel studs/nuts should not be lubricated with oil or grease. The use of a lubricant on the threads could cause the lug nuts to loosen.

CAUTION: Most vehicle manufacturers also specify that the wheel studs/nuts should not be lubricated with oil or grease. The use of a lubricant on the threads could cause the lug nuts to loosen.
Figure 111-16  This wheel was damaged because the lug nuts were not properly torqued.

Figure 111-17  The method most often recommended is the modified X method. Using this method, each tire eventually is used at each of the four wheel locations. An easy way to remember the sequence, whether front wheel drive or rear wheel drive, is to say to yourself, “Drive wheels straight, cross the nondrive wheels.”
**TECH TIP: All-Wheel-Drive Tire Concerns**

It is very important that all-wheel-drive vehicles be equipped with tires that are all the same outside diameter. If, for example, the vehicle has 30,000 miles and the tires are half worn, all of the tires should be replaced in the event of a problem requiring replacement of only one tire. Most vehicle manufacturers specify that all tires must be within 2/32 in. of tread depth without causing a constant strain on the drive train.

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**Figure 111-18**  Tire showing excessive shoulder wear resulting from underinflation and/or high-speed cornering.

**Figure 111-19**  Tire showing excessive wear in the center, indicating overinflation or heavy acceleration on a drive wheel.
Figure 111-20  Wear on the outside shoulder only is an indication of an alignment problem.

Figure 111-21  A tire runout gauge being used to measure the radial runout of a tire.

Figure 111-22  To check wheel radial runout, the dial indicator plunger tip rides on a horizontal surface of the wheel, such as the bead seat.
FREQUENTLY ASKED QUESTION

I Thought Radial Tires Couldn’t Be Rotated!
When radial tires were first introduced by American tire manufacturers in the 1970s, rotating tires side-to-side was not recommended because of concerns about belt or tread separation. Since the late 1980s, most tire manufacturers throughout the world, including the United States, have used tire-building equipment specifically designed for radial-ply tires. These newer radial tires are constructed so that the tires can now be rotated from one side of the vehicle to the other without fear of causing a separation by the resulting reversal of the direction of rotation.

Figure 111-23 To check lateral runout, the dial indicator plunger tip rides on a vertical surface of the wheel, such as the wheel flange.

FREQUENTLY ASKED QUESTION

Is the Age of a Tire Important?
Yes. The National Highway Traffic Safety Administration (NHTSA) recommends that any tire six years old or older should be replaced regardless of tread depth. This means that tires that look almost like new but are six years old or older should be replaced because the NHTSA determined that age, not tread depth, was a major factor in tire failures.
THE MOST ACCURATE METHOD OF MEASURING WHEEL RUNOUT IS TO Dismantle the tire and take dial indicator readings on the inside of the wheel rim.

REAL WORLD FIX: The Greased Wheel Causes a Vibration

Shortly after an oil change and a chassis lubrication, a customer complained of a vibration at highway speed. The tires were checked for excessive radial runout to be certain the cause of the vibration was not due to a defective out-of-round tire. After removing the wheel assembly from the vehicle, excessive grease was found on the inside of the rim. Obviously, the technician who greased the lower ball joints had dropped grease on the rim. After cleaning the wheel, it was checked for proper balance on a dynamic computer balancer and found to be properly balanced. A test-drive confirmed that the problem was solved.

A wheel balancer detects heavy spots on the wheel and tire, and indicates where to place weight to offset both static and dynamic imbalance.
Figure 111-26  An assortment of wheel weights designed to fit different shaped rims.

Figure 111-27  Liquid tire stop leak was found in all four tires. This liquid caused the tires to be out of balance.

Figure 111-28  Stick-on weights are used from the factory to balance the alloy wheels of this Prowler.
REAL WORLD FIX: The Vibrating Ford Van

A technician was asked to solve a vibration problem on a rear-wheel-drive Ford van. During test drives, the vibration was felt everywhere—the dash, the steering wheel, the front seat, the shoulder belts; everything was vibrating! Even though wheel weights were put on all four wheels and tires, the vibration persisted. The vibration was even worse than before. The technician replaced all four wheel tires after that, but the vibration was still present. The shop continued to try different weight configurations, but no matter what was tried, the vibration persisted. The shop supervisor then took over the job of solving the mystery of the vibrating van. The supervisor balanced one wheel and determined the balance was way off after installing the weights. He broke down the tire and found about 1 quart (1 liter) of liquid in the tire! No wonder the tire couldn’t be balanced! Every time the tire stopped, the liquid would settle in another location.

The customer later admitted to using a tire stop-leak liquid in all four tires. Besides stop leak, another common source of liquid in tires is water that accumulates in the storage tank of air compressors, which often gets pumped into tires when air is being added. All air compressor storage tanks should be drained of water regularly to prevent this from happening. - SEE FIGURE 111–27.

Figure 111-29  Wheel weight pliers are specially designed to remove and install wheel weights.

TECH TIP: Stop Leak Can Damage TPMS Sensors

Stop leak should never be used in a tire that is equipped with the TPMS sensor because the sensor can be damaged.
FREQUENTLY ASKED QUESTION

How Much Is Too Much Weight?
Whenever balancing a tire, it is wise to use as little amount of weight as possible. For most standard-size passenger vehicle tires, most experts recommend that no more than 5.5 oz of weight be added to correct an imbalance condition. If more than 5.5 oz total weight is needed, remove the tire from the wheel (rim) and carefully inspect for damage to the tire or the wheel. If the tire still requires more than 5.5 oz and the wheel is not bent or damaged, replace the tire.

FREQUENTLY ASKED QUESTION

Are the Brake Drums and Rotors Balanced?
Whenever an off-the-vehicle computer balancer is used, a question often asked by beginning technicians is: “What about the balance of the brake drums and rotors?” Brake drums and rotors are balanced at the factory, usually to within 0.5 oz-in. Imbalance measured in oz-in., means that any imbalance force is measured in ounces, then multiplied by the distance from the center measured in inches. Thus, if in a drum or rotor, an imbalance is found in one location, the reason will be the distance from the center is not within the 0.5 oz-in. limit. Being within 0.5 oz-in. also means that at 5 inches from the center, the imbalance is only 0.1 ounce.

What this means to the technician is that most drums and rotors are balanced well enough not to be a problem when using off-the-vehicle balances. However, the smart technician should look for evidence that weights have been removed from the drums and/or rotors to permit aluminum wheels to fit, or other cases where the factory balance of the drums and rotors has been changed.
Most brake drums do not have this much attached weight.

**REAL WORLD FIX:** *It Happened to Me—It Could Happen to You*

During routine service, I rotated the tires on a Pontiac Trans Am. Everything went well and I even used a torque wrench to properly torque all of the lug nuts. Then, when I went to drive the car out of the service stall, I heard a horrible grinding sound. When I hoisted the car to investigate, I discovered that the front wheels were hitting the outer tie rod ends.  

**SEE FIGURE 111–32.** The 16-in. wheels had a different back spacing front and rear, and therefore these wheels could not be rotated. Always check replacement or aftermarket wheels for proper fit before driving the vehicle.

**FREQUENTLY ASKED QUESTION:** *What Are Hubcentric Wheels?*

Most wheels are designed to fit over and be supported by the axle hub. This type of wheel is called a hubcentric type wheel. Some wheels use an enlarged center hub section and rely on the wheel studs for support and to keep the wheel centered on the axle. Some aftermarket wheels may be designed to fit several different vehicles. As a result, the wheel manufacturers use plastic hubcentric adapter rings. 

**SEE FIGURE 111–33.**
Notice that the rim touches the tie rod end.

Figure 111-33 (a) A hubcentric plastic ring partially removed from an aftermarket wheel.

Figure 111-33 (b) A hubcentric plastic ring left on the hub when removing a wheel.
Figure 111-34  The area of the repair should be buffed slightly larger than the patch to be applied.

Figure 111-35  A stitching tool being used to force any trapped air out from under the patch.

Figure 111-36  A rubber plug being pulled through a hole in the tire. The stem is then cut off flush with the surface of the tire tread.
TECH TIP: Dispose of Old Tires Properly

Old tires cannot be thrown out in the trash. They must be disposed of properly. Tires cannot be buried because they tend to come to the surface. They also trap and hold water, which can be a breeding ground for mosquitoes. Used tires should be sent to a local or regional recycling center where the tires will be ground up and used in asphalt paving or other industrial uses. Because there is often a charge to dispose of old tires, it is best to warn the customer of the disposal fee.

WARNING:

Most experts agree that tire repairs should be done from the inside. Many technicians have been injured and a few killed when the tire they were repairing exploded as a steel reamer tool was inserted into the tire. The reamer can easily create a spark as it is pushed through the steel wires of a steel-belted tire. This spark can ignite a combustible mixture of gases inside the tire caused by using stop leak or inflator cans. Since there is no way a technician can know if a tire has been inflated with a product that uses a combustible gas, always treat a tire as if it could explode.

TECH TIP: Open-End Wrenches Make it Easier

Tire repair is made easier if two open-end wrenches are used to hold the beads of the tire apart. See step 4 in the tire repair photo sequence.
A typical tire-changing machine showing the revolving table and movable arm used to remove a tire from the wheel.

The foot-pedal controls allow the service technician to break the tire bead, damp the wheel (rim) to the machine, rotate the tire/wheel assembly, and still have both hands free.

Using a tire valve removal tool, unscrew the valve core using extreme caution and wear eye protection because the valve is under pressure and can be forced outward and cause personal injury.
The valve core is removed from the tire valve. Allow all of the air in the tire to escape.

A bead breaker is being used to separate the tire from the bead seat of the wheel. Repeat as needed to break the bead on both sides of the wheel.

After breaking the beads from both sides of the tire, install the wheel/tire assembly flat onto the machine and, using the foot-pedal control, lock the wheel to the changer.
TIRE MOUNTING 7. To remove the tire from the wheel, position the arm of the changer against the rim of the wheel and lock in position.

TIRE MOUNTING 8. The tire tool (flat bar) is placed between the bead of the tire and the wheel. Using tire lubricant can help prevent damage to the tire.

TIRE MOUNTING 9. The foot pedal that causes the table to rotate is depressed and the tire is removed from the wheel.
TIRE MOUNTING 10 Reposition the tire tool to remove the lower bead of the tire from the wheel.

TIRE MOUNTING 11 As the table of the tire changer is rotated, the tire is released from the wheel and can be lifted off the wheel.

TIRE MOUNTING 12 Before installing a tire, inspect and clean the bead seat.
Before installing a new tire, most experts recommend replacing the tire valve, being installed here, using a tool that pulls the valve through the hole in the wheel.

Apply tire soap or rubber lubricant to both beads of the tire.

Rotate the tire on the wheel and position the arm so that the tire will be guided onto the rim as the wheel is rotated.
TIRE MOUNTING 16
Repeat for the upper bead.

TIRE MOUNTING 17
Inflate the tire, being careful not to exceed 40 PSI. Experts suggest that a cage be in a cage during the initial bead seating inflation to help prevent personal injury if the wheel or tire fails.

TIRE MOUNTING 18
Install the tire valve core and inflate the tire to specifications.
TIRE REPAIR 1. The source of the leak was detected by spraying soapy water on the inflated tire. Needle-nose pliers are being used to remove the object that caused the flat tire.

TIRE REPAIR 2. A part of a razor blade was found to be the cause of the flat tire.

TIRE REPAIR 3. A reamer is being used to clean the puncture hole.
TIRE REPAIR 4. This technician is using two open-end wrenches to hold the tire beads apart if a tire bead spreader is not available.

TIRE REPAIR 5. The surrounding area is being buffed using an air-powered die grinder equipped with a special buffing tool specifically designed for this process.

TIRE REPAIR 6. After using a vacuum on all debris and rubber after buffing, apply rubber cement to the area.
TIRE REPAIR 7  The brush included with the rubber cement makes the job easy. Be sure to cover the entire area around the puncture.

TIRE REPAIR 8  Peel off the paper from the adhesive on the patch. Insert the tip of the patch through the puncture from the inside of the tire.

TIRE REPAIR 9  Use a pair of pliers to pull the plug of the patch through the puncture.
This view of the patch is from the inside of the tire.

To be assured of an airtight patch, the adhesive of the patch should be "stitched" to the inside of the tire using a serrated roller called a stitching tool.

A view of the plug from the outside of the tire after metal covering used to punch the puncture is removed from the patch plug. The plug can be trimmed to the level of the tread using side cutters or a knife.