The Pennsylvania State University
Workforce Education and Development

Lesson Plan Template

Name of Instructor:Brian Stevens
Program Title:Automobile/Automotive Mechanics Technology/Technician
Course Title: Automotive Mechanics
Unit Title: Wheels and Tires
Lesson Title: Wheel and Tire Design
Lesson Performance Objective:Given information on wheel and tire design,Basic Construction,Maintenance, and how to obtain basic information on tire grades and ratings.
Time (length of lesson):1 hr.
Equipment and Materials needed:Information Package and question sheet.
Technical Standard(s):105,111,536,546
Academic Standard(s):CIP 47.0604 Follow precisely steps to identify and obtain information related to proper tire and wheel use.
Introduction : Students will read and answer questions to identify types of wheels and tires, and where to find proper information.

Body:General information on wheel and tire design,Basic wheel construction, Tire Monitoring Systems,Proper tightening procedures,Tire construction, Spare tires,Tire grades and ratings, and where proper identification is located on the tire or on the vehicle.

Summary:Given information to use specifications for proper application for vehicle and where to locate information needed.

Student Assessment:

Formative Assessment(s)

Summative Assessment:

Universal Design for Learning (UDL)

Multiple Means of Engagement:

Multiple Means of Representation:

Multiple Means of Expression:

UNIT 4: WHEELS AND TIRES

The following topics are addressed in this unit:

Wheel and Tire Design

- Basic Wheel Construction
- Wheels with Tire Pressure Sensors
- Wheel Maintenance
- Tire Design
- Tire Construction
- Grades and Ratings
- Tire Placard

Wheel and Tire Service

- Inflating and Inspecting tires
- Rotating the Tires
- Mounting Tires
- Repairing Tires
- Measuring and Correcting Wheel Runout
- Correcting Tire/Wheel Imbalance

WHEEL AND TIRE DESIGN

BASIC CONSTRUCTION

BASIC WHEEL CONSTRUCTION

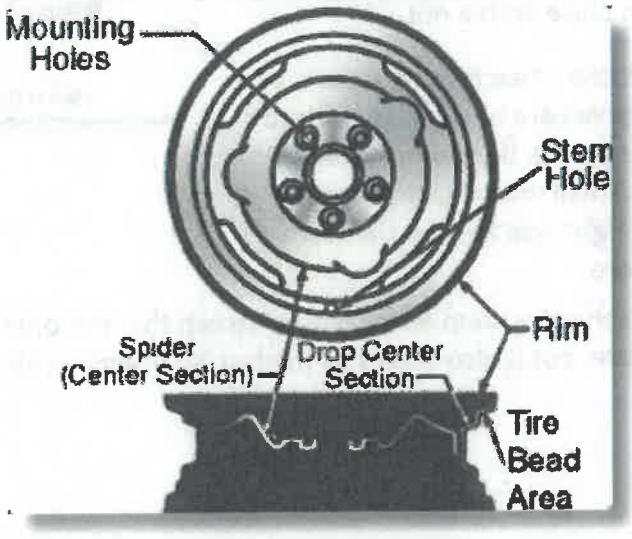
Wheels are made from either stamped steel, cast or forged aluminum, or alloys.

A wheel consists of the following basic parts:

- Holes for the mounting wheel lugs
- Rim
- Hole for a valve stem
- Dropped center section
- Bead section

A wheel usually has between four and six mounting holes that connect the wheel to the hub of the vehicle.

Typical Wheel Construction



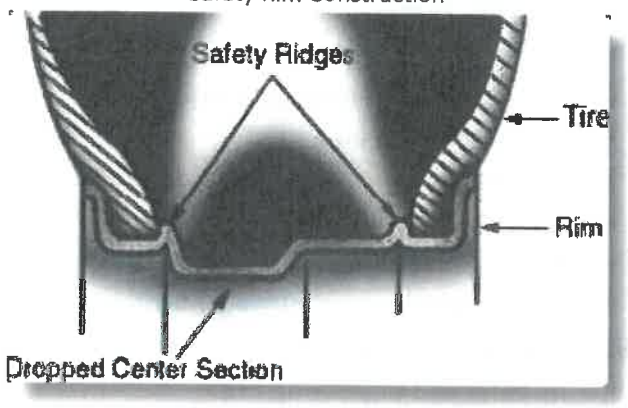
Wheel sizes are designated by the diameter of the wheel, from bead to bead, and also by the width of the wheel between the rim flanges. The diameters of wheels for passenger vehicles range from 12 inches to 20 inches, and more on some custom versions.

Wheels with Safety Rims

Some rims have a safety ridge near the lip of the wheel ridge that helps keep the tire from entering the inner depressed part of the wheel. This lip helps to prevent the bead from unseating if the vehicle corners hard, or if the tire goes flat while the vehicle is moving.

The inner depressed area of a wheel allows for tire bead clearance during mounting. A tire machine can then be used to stretch the other bead over the wheel ridge.

Safety Rim Construction

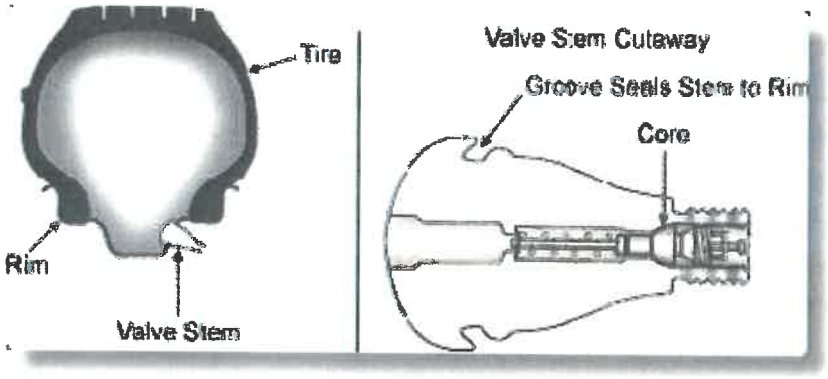


Valve Stems

Valve stems are mounted in wheels to enable the addition or removal of air from a tire. If a valve stem is made from rubber, it will simply snap into the hole. Other valve stems are made from metal and are held in place with a nut.

Inside of each valve stem is a **valve core** which allows air to enter the tire during inflation. A small return spring keeps a tight seal around the valve core.

Valve Stem Placement and Construction



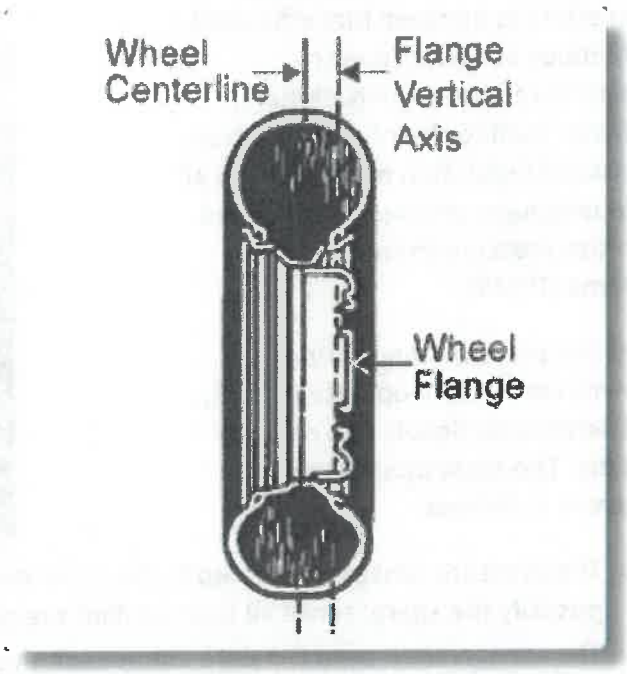
Each valve stem also has a **valve cap** that not only keeps dirt and contaminants out of the valve core, but it also serves as the last 'seal' against air leakage.

Wheel Offset

Factory-installed wheels are designed to have the necessary clearance for brake and suspension components. Wheels are also designed to distribute the vehicle load evenly on all of the wheel bearings.

Offset is the distance, in inches or millimeters, between the vertical centerline of a rim and the mounting flange of the wheel's center. If the centerline of a rim is inboard of the mounting flange of the wheel's center, it is considered to have a **positive offset**. However, if the centerline of a rim is outboard of the mounting flange of the wheel's center, it has a **negative offset**.

Wheel Offset



Types of Wheel Designs

Stamped Steel Wheels

One type of automotive wheel is made from stamped steel and consists of two pieces; the center and the rim.

On this type of wheel the center section is either riveted or spot welded to the rim (the outer portion). The mounting holes on these wheels are also tapered to match the tapered wheel **lug nuts**. This tapering helps to center the wheel on the **wheel studs**.

Stamped steel wheels are typically fitted with a hubcap.

Cast and Forged Wheels

Many wheels today are constructed of materials that are lighter than steel, such as aluminum and aluminum alloys. This is done because of the fact that lighter wheels help vehicles achieve better fuel efficiency.

Aluminum wheels usually have a high-quality, polished, finish and hubcaps are not normally used.

Note: The term 'mag wheel' is commonly given to wheels made from magnesium or other alloys.

Pressure Sensors

Wheels with Tire Pressure Sensors

In an effort to increase fuel efficiency, and reduce accidents due to underinflated tires, the National Highway Traffic Safety Administration has issued legislation requiring that all new passenger vehicles be equipped with **tire pressure monitoring systems** (TPMS).

Typical Tire Pressure Sensor

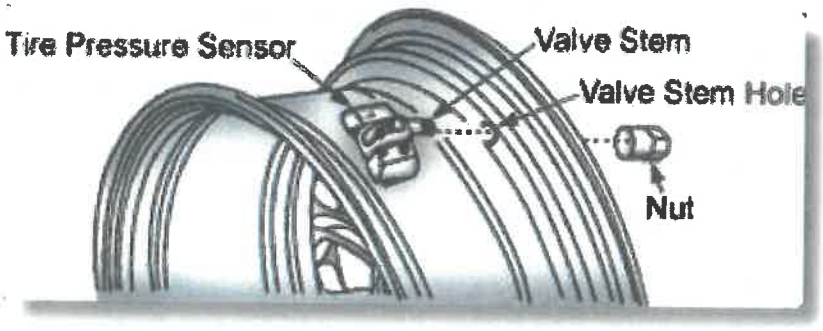
Most tire pressure monitoring systems use battery-operated sensors that send radio signals to a receiver module. The basic operation of the system is as follows:

1. Tire pressure sensors, mounted in the valve stem holes of all four wheels on the vehicle and possibly the spare, sense all four (or five) tire pressures.
2. The sensors then send the data about each tire to a receiver module, where it is compared to programmed specifications.
3. If the system senses that one or more of the tire pressures has gone below, or above, a certain level, then the module will send a signal to a display on the dashboard to warn the driver.

Basic Components of a TPMS

- Tire pressure sensors, which are composed of a transmitter, battery, valve stem with core and cap, mounting nut, and sealing grommet
- Electronic receiver module with dashboard icon for incorrect pressure/ malfunction display
- Special magnet tool for programming the tire pressure sensors (some systems)

Tire Pressure Sensor Mounting



The following are some of the advantages of maintaining proper tire pressure:

- Enhanced safety due to fewer tire blowouts and improved vehicle handling
- Better fuel economy
- Longer tire life

Wheel Maintenance

Wheel Offset

When replacing a factory wheel, or installing an aftermarket wheel, always use one that has the same offset (positive or negative) as the original.

Many aftermarket wheels have an offset that is different from the original factory wheel. A difference in the offset of a replacement wheel can affect wheel alignment, vehicle handling, and tire wear. A different offset can also affect the weight distribution on the spindle and wheel bearings, causing the premature failure of those components.

Wheel Runout

Wheels can become damaged from accidents, age (rust), and hitting large potholes or curbs. Any wheel that becomes damaged should be replaced before the vehicle is used again.

Rims can be measured for runout to determine if the wheel is either out-of-round or 'wobbling'. Wheels can have either **lateral runout** (side-to-side) or **radial runout** (out-of-round), and either can be measured with a dial indicator.

If a wheel's runout exceeds the manufacturer's specifications, it should be replaced since excessive wheel runout can cause a vehicle to shimmy or vibrate.

Torque specifications

It is important to torque all wheels (steel or alloy) to the proper specifications for the following reasons:

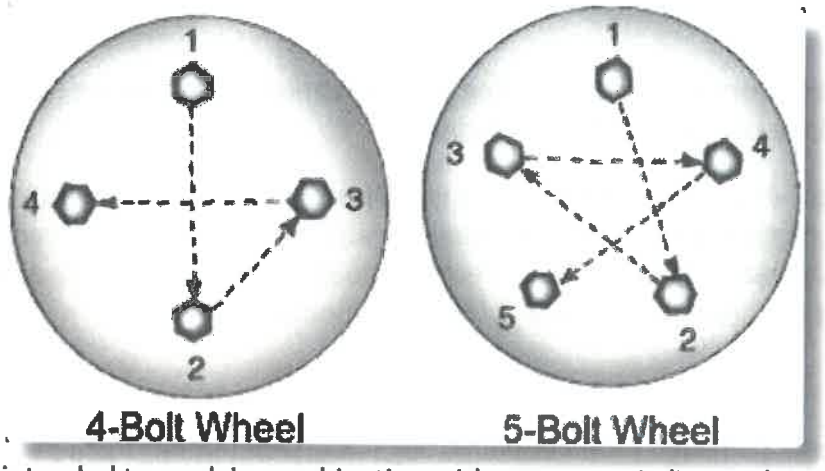
- If the lug nuts are not sufficiently tight, the wheel may fall off while it is driven.
- The lug nuts may vibrate loose and, once they are loose, the wheels can shear the studs off of the hub.
- If the lug nuts are too tight, the disc brake rotors may become distorted or warped.
- If the lug nuts are too tight, the driver may not be able to loosen the lug nuts with a hand lug wrench in an emergency.
- If the wheel studs or nuts become stripped, premature failure will occur.

Note: Lug nut torque specifications typically range from 80 ft-lb (foot-pounds) to 120 ft-lb, but always check the manufacturer's specifications.

Always tighten all lug nuts in the correct sequence. Failure to do so could result in bending or warping the wheel, brake drum, or brake rotor.

When tightening lug nuts, ensure that the taper of the lug nut is toward the wheel. Snug the lug nuts up to the wheel hand-tight and then tighten in the correct sequence, and to the correct specifications, with a torque wrench (manually) or with a torque stick (using pneumatic tools).

Lug Nut Tightening Sequences



Torque sticks are intended to work in combination with a pneumatic (impact) wrench to install lug nuts. They consist of a set (usually four to eight pieces) of color-coded, long-shafted sockets that are designed to 'flex' with the wrench's pulses, once the rated torque has been reached. In that way, torque sticks prevent the over-torqueing of lug nuts.

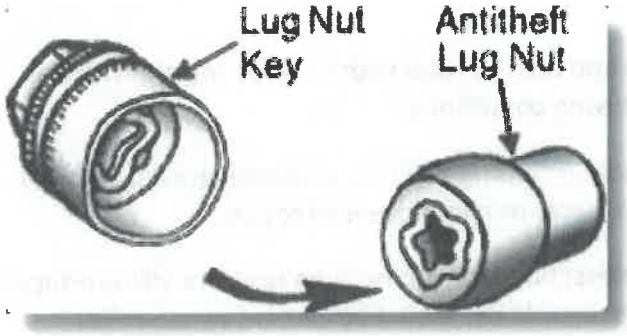
The difference in the torque ratings of torque sticks is determined by their shaft's diameters; the larger the diameter, the higher the torque rating. The manufacturers of torque sticks also provide an application chart for most vehicles.

Antitheft lug nuts

Antitheft lug nuts are used on many cars today to prevent the wheels and tires from being stolen. Usually, one antitheft lug nut is used per wheel.

The manufacturer of the vehicle, or aftermarket lug nut set, will supply a special lug nut 'key' that fits the antitheft lug nuts and must be used to loosen or tighten the antitheft lug nuts. The antitheft lug nuts should be torqued to the same value as the regular nuts to aviod bending or distorting the wheel, brake drum, or brake rotor.

Anti-Theft Lug Nut and Key



Anti-Theft Lug Nuts and Sockets

Tire Design

Purpose and Basic Design of Tires

Automotive tires are designed to provide traction and absorb road shocks. They must perform well on a variety of road surfaces and in various driving conditions.

Tires must provide traction effectively on all surfaces including asphalt, concrete, gravel, and dirt. They must do this not only on dry roads, but also on wet or snow-covered roads.

Most of the tires used in today's vehicles are tubeless; however, some tube tires are still produced. In a tubeless tire, the tire and wheel must both be capable of retaing air under pressure. To accomplish this, a synthetic gum rubber liner is built into tires to prevent air from leaking through the tire fabric.

In tires that use tubes, both a tire and an inner tube are mounted on a wheel. The tube is inflated and retains the air instead the tire itself. As mentioned previously, tires with tubes are seldom found in today's cars and light trucks.

Note: Tire manufacturers use both natural and synthetic rubber components in the construction of modern tires.

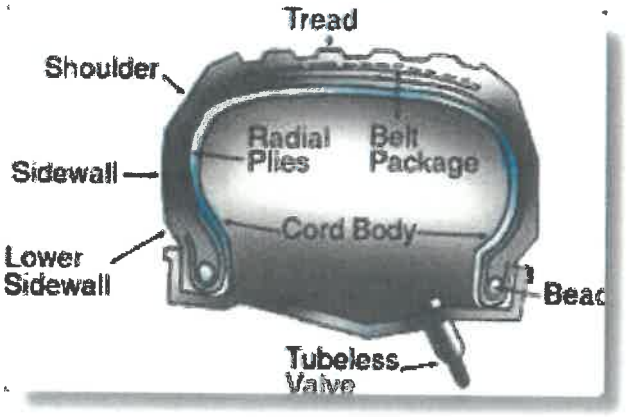
Tire Construction

The three basic types of cord body construction for passenger tires are bias, belted bias, and radial ply. All tire types have the following components: beads, cord body, tread, and sidewalls.

Tire **beads** are bands of strong steel wire that fasten to the tire plies and are molded to the inner circumference of a tire. These beads are responsible for holding the tire in position on the rim.

The **cord body** connects to the steel bead wires. A cord body consists of layers of rubber-impregnated fabric (plies) which are molded together, in rubber, to form the tire. The way the plies are assembled determines the tire's construction (radial plies, belted bias, etc.) while the number of plies determines the tire's load-carrying capacity.

Typical Tire Construction



A tire's **tread** is the part that actually contacts the road. During construction, a tread's rubber is molded directly to the cord body, along with additional rubber that is also molded to the cord body sidewalls. Manufacturers use varying tread patterns, and rubber compounds, to fulfill specific tire requirements and applications.

Sidewalls are the area where the tread of a tire connects to the bead. A tire's sidewall is made from rubber compounds that absorb shocks and irregularities in the road. The flexibility of a sidewall gives a vehicle either a smooth ride or a firmer ride.

Tires are made from various compounds, as listed below:

- Fabric (steel, nylon, aramid fiber, fiberglass, polyester)
- Rubber (natural and synthetic)

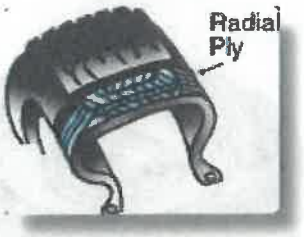
  Note: The sidewall rubber is not as thick as the rubber on the tread.

  Note: The rubber compounds contain antioxidants that help prevent cracking from the sun's ultraviolet radiation.
- Reinforcing chemicals (carbon black, silica, resins)
- Antidegradants (antioxidants)
- Adhesion promoters (cobalt salts, brass on wire, resins on fabrics)
- Curatives (cure accelerators, activators, sulfur)
- Processing aids (oils, tackifiers, peptizers, softeners)

Cord Body Construction

On **Radial ply tires**, the plies of the cord body run in straight lines, parallel to each other, and perpendicular to the beads. This construction method also puts the plies at right angles to the tire tread. Two or more additional belts, made of either fabric or steel, also lay on top of the cord body, and under the tread section.

Radial Ply Tire Construction

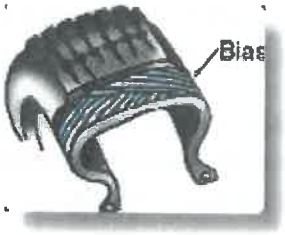


Radial ply tires provide better traction, increased tread life, and a softer ride at medium and high speeds, and are used on a majority of today's passenger cars. In addition, they also exhibit less rolling resistance, which is a measurement of how much friction a tire produces as it rolls on the road. Lower rolling resistance helps to provide increased fuel economy.

Note: Do not use both radial and bias ply tires on the same vehicle as these two types of tires have significantly different handling characteristics.

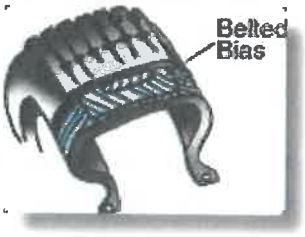
Bias ply tires consist of two or more plies, placed one on top of another, that run in a crisscross (bias) pattern from bead to bead. These plies are constructed from a combination of materials such as rayon, nylon, polyester, etc.

Bias Ply Tire Construction



Belted bias tires are constructed similar to bias ply tires, except they have two or more layers of tread-reinforcing plies, or belts, that wrap around the circumference of the tire, under the tread. These belts are positioned under the tread area only and do not extend to the sidewalls. Usually constructed of fiberglass, rayon, or steel, these additional belts provide better wear, handling, and increased puncture resistance.

Belted Bias Tire Construction



Specialty Tires: Compact Spares

A **temporary-use spare** is a type of compact spare tire that is commonly supplied with passenger cars today. Compact spare tires are used because they take up less space in a vehicle's trunk, or luggage compartment, than a full-size spare tire.

Temporary-use spares are designated with a T as their alphanumeric size. Although the inflation specification on temporary spares is typically about 60 psi, the top speed is rated at only about 50 mph.

Temporary Use Spare Tire

A **space-saver spare** is another type of spare tire that is supplied with some vehicles.

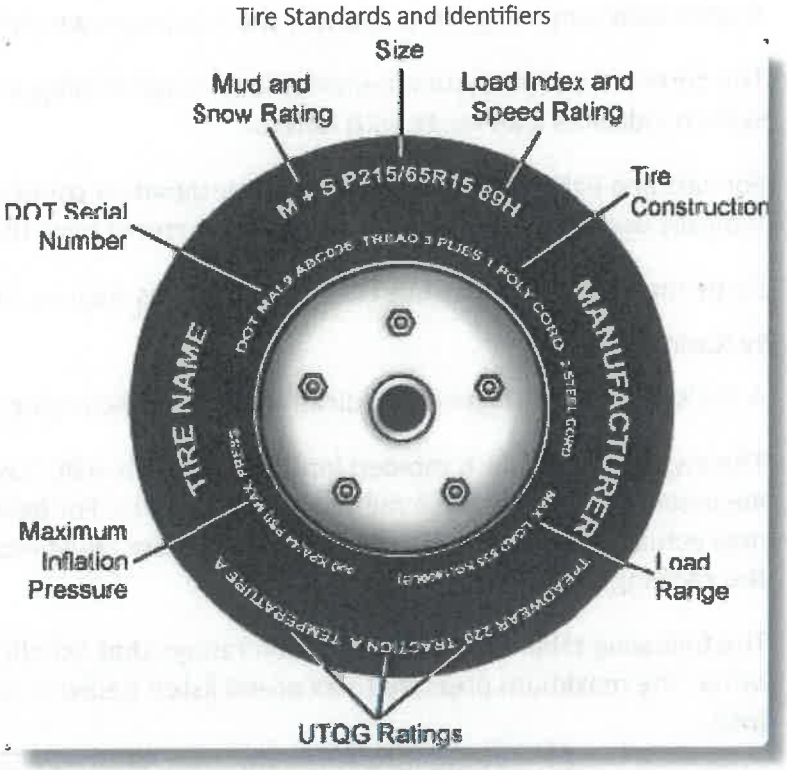
This type of tire is inflated (to about 35 psi) using a special air compressor that comes with the vehicle. While inflating one of these tires, ensure that there are no folds in the sidewall.

CAUTION: Never substitute compact spare tires for regular tires since they are not rated for either the speed or distance of passenger tires. They are to be used only for emergencies, and even then only for short distances and at reduced speeds, until reaching a service facility.

Grades and Ratings

The **Uniform Tire Quality Grading Standards,** developed by the National Highway Traffic Safety Administration, are the official standards used for passenger car tires. These standards provide the criteria for rating tires in the categories of tread wear, traction, and the ability to dissipate heat.

Note: A tire's rating in these various categories is molded into the tire's sidewall during its construction. The graphic at right shows some of the information found on tires.



In the category of **tread wear** (length of tread life), each tire is assigned a grade number (e.g., 90, 100, etc.) with tread life increasing as the number increases. For example, a tire with a grade of 180 should wear twice as long as one with a grade of 90.

The letters A, B, and C are used to rate a tire's ability to provide traction on wet roads. A tire with an 'A' rating offers the best traction under wet conditions, whereas a 'C' offers minimum traction under the same conditions.

The letters A, B, and C are also used to indicate the tire's ability to dissipate or resist heat. A tire with a rating of 'A' has the greatest ability to dissipate or resist heat, whereas a tire rated 'C' has the least ability to do so.

Speed Rating

A tire's **speed rating** indicates the maximum speed at which a tire can operate safely. Be aware that speed ratings become invalid if a tire is damaged, underinflated, overinflated, or overloaded. The letters used to designate the maximum speed rating of tires, are listed below.

- S - 112 mph
- T - 118 mph
- U - 124 mph
- H - 130 mph
- V - 149 mph
- Z - 149+ mph

Load Range

A tire's **load range** is given to identify the maximum weight each tire size can safely carry.

The current P-metric system indicates load range in kilograms and pounds while the alphanumeric system indicates load range with letters.

For cars and light trucks, the letters that designate a common load range are B, C, D, and E. Cars typically use a load range of B, whereas light trucks have tires with load ranges of C, D, or E.

Some manufacturers also use other designations such as: SL (standard load) and XL (extra load).

Ply Rating

A tire's **ply rating** is a general indication of its load-carrying capacity.

The ply rating of a tire is molded into the tire's sidewall, however, the rating number is not necessarily the same as the number of actual plies. For example, a tire with a two-ply sidewall may actually have a four-ply rating. The way a tire could receive this rating is if its design gave it the carrying capacity of four plies.

The following table represents common ratings that usually, but not always, correlate with each other. The maximum pressure (max press) listed below is measured in pounds per square inch (psi).

Common Comparisons for Car and Light Truck Radial Tires		
Load Range	**Ply Rating**	**PSI Max Press**
B	4	35
C	6	50
D	8	65
E	10	80

Load Index and All-Season Tires

Load index

Most manufacturers use a new marking system to designate **load index**. These two- to three-digit numbers usually precede a speed-rating letter and, the higher the load index number, the greater the load that the tire can carry. For example, a tire sidewall may have a marking of 90H where '90' is the load index and 'H' is the speed rating.

All-season tires

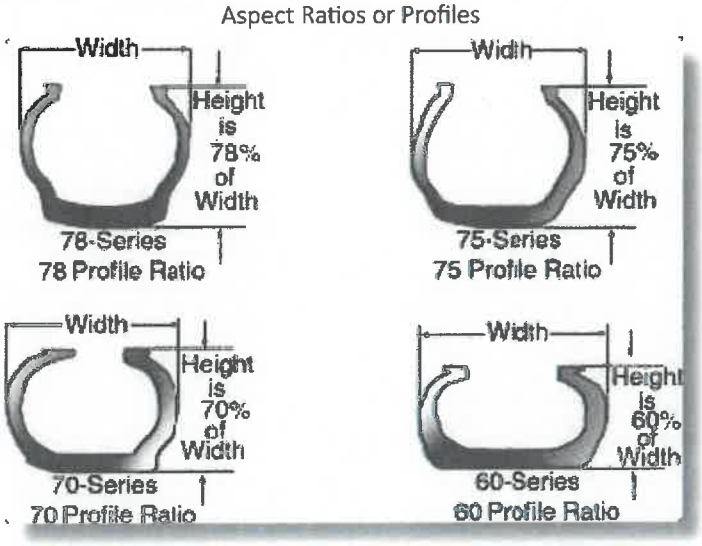
Some tire manufacturers also use the letters M and S to identify that the tire performs as required in mud or snow. Tires with these designations are commonly called **all-season tires**.

Winter Tires

Some tire manufacturers also use the three peak mountain/snowflake symbol for to identify that the tire meets more stringent winter traction performance requirements and has been rated for "severe snow service." Tires with this designation are commonly called winter tires. Most tires do not qualify for the mountain/snowflake symbol because the tread rubber in all-season and summer tires become hard at temperatures below 40 F.

Sizing

In order to understand tire sizing, it is first important to understand **aspect ratio**, which is the relationship of a tire's sidewall height to its width. Other terms for aspect ratio are **profile**, and **Series**.



One example of this aspect ratio is that a 70-series tire will be 70% as tall as it is wide. The most common tire series are 60, 70, 75, and 80, although some are much smaller.

In terms of actual tire sizes, a combination of U.S. and metric units is used to designate most tires today. For instance, one of the common tire sizes used today is the P225/60R16. The following is an explanation of this tire's designations.

The first letter of a tire size, in this case 'P', indicates the tire type from the list below.

- P = passenger car (as shown in the example)
- T = temporary
- C = commercial
- LT = light truck

The next three digits indicate the **section width** in millimeters. In the example given, 225 = 225 millimeters. Note that section width is the measurement from the outer sidewall, to the inner sidewall, at the widest part of the tire, when the tire is mounted and inflated. Be careful not to confuse section width with tread width.

The next two digits indicate the aspect ratio, that is, section height/ section width. In the example above, the section height is 60% of the section width.

The next letter indicates the construction type.

- R = radial (as shown in the example cited)
- B = belted bias
- D = diagonal (bias)

The final two digits indicate the rim diameter in inches. In the example cited, the rim diameter is 16 inches.

Tire Placard

Most vehicles have a placard that is permanently located on the vehicle, usually on the driver's door jamb, which gives information regarding the vehicle's tires. A placard example is shown at right.

Both drivers and service technicians should refer to the tire placard for tire information including inflation pressure, maximum vehicle load, and tire size, wheel size, etc.

Typical Tire Placard

MFD BY 09/99

GVWR	GAWR FRT	GAWR RR
2200KG(4850LB)	1134XG(2500LB)	1225KG(2700LB)

THIS VEHICLE CONFORMS TO ALL APPLICABLE U.S. FEDERAL MOTOR VEHICLE SAFETY AND THEFT PREVENTION STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

1GNCT18W4XK187526 TYPE: M.P.V.

MODEL: T10516 PAYLOAD = 348KG(768LB)

TPBS	TIRE SIZE	SPEED RTG	RIM	COLD TIRE PRESSURE
FRT	P235/70R15	S	15X7J	220KPA(32PSI)
RR	P235/70R15	S	15X7J	220KPA(32PSI)
SPA	P235/70R15	S	15X7J	240KPA(35PSI)

SEE OWNER'S MANUAL FOR MORE INFORMATION.

DOT/MOT number

All tires have a number designated by either the U.S. Department of Transportation (DOT) or the Canadian Ministry of Transportation (MOT). This number identifies where and when the tire was manufactured and also identifies the tires for warranties and possible recalls.

Wheels and Tires

Name_____

1.Wheels are made from either _____ _____, cast or forged_____,or _____.

2._____ _____ are mounted in wheels to enable the addition or removal of air from a tire.

3.It is important to _____ all wheels to the proper specifications.

4.When tightening lug nuts, ensure that the taper of the nut is _____ the wheel.

5.Automotive tires are designed to provide_____ and absorb _____ _____.

6.The three basic types of cord body construction for passenger tires are _____, _____ _____, and _____.

7.A tire's _____ is the part that actually contacts the road.

8. _____ are the area where the tread of a tire connects to the bead.

9.A _____ -use spare is a type of compact spare tire that is commonly supplied with passenger cars today.

10.Most vehicles have a _____ that is permanently located on the vehicle,usually on the driver's door jamb,which gives information regarding the vehicle's tire.