Automotive Mechanics

Level-II

Based on March 2022, Curriculum Version 1

Module Title: - Carrying out Wheel Alignment

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Nominal duration: 60 Hour

Prepared by: Ministry of Labor and Skill

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Acknowledgment

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Acronym

CD-ROM	Compact Disc, Read-Only-Memory
CV joint	Constant Velocity joint
ISO	LAP test
LAP Test	Learning Activity Performance test
OS	Occupational Standard
SAI	Steering Axis Inclination
SUV	Sport Utility Vehicle

Introduction to module

In Automotive field of study; a wheel alignment is very crucial process in this sector. Which including adjusting the angles of your vehicle's steering and suspension components back to original specifications. It involves basic check/test, alignment equipment installation, measurement and adjustment according to workplace requirements. Additionally, this module covers performing post-service checks and documentation.

This module contain carrying out Wheel Alignment vehicle's steering and suspension components

This module is designed to meet the industry requirement under the automotive mechanics level II occupational standard, particularly for the unit of competency: **Carrying out Wheel Alignment.**

This module covers the units:

- Carry out wheel alignment pre-checks
- Perform wheel alignment
- Clean up work area and maintain equipment

Learning Objective of the Module

- Carryin out wheel alignment pre-checks
- Performing wheel alignment
- Clean up work area and maintain equipment

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the "LAP test" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Carry out wheel alignment pre-checks

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Wheel alignment requirements
- Pre-alignment inspection
- Need for alignment
- Manufacturer/component supplier specifications
- Alignment Angle Diagnostic Chart

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify wheel alignment requirements
- Perform pre-alignment inspection
- Testing vehicle to confirm need for alignment
- Interpreting manufacturer/component supplier specifications
- Alignment Angle Diagnostic Chart

1.1 Wheel alignment requirement

Wheel alignment involves a mechanical adjustment of vehicle suspension to influence the direction and angle of the tire's contact with the road surface. The optimum alignment for each make and model of vehicle is set by the manufacturer in order to influence the performance and handling. Alignment also impacts upon safety and tire wear hence, an important element of servicing that should be completed at regular intervals.

All-wheel-drive or four-wheel-drive vehicle, you have to get a four-wheel alignment. On the other hand, if your vehicle uses a front-wheel-drive or rear-wheel-drive system, it needs a front-end alignment or thrust-angle alignment.

Different car models have different alignment specifications which are determined by the manufacturers. We use a special computerized alignment machine that is pre-loaded with every vehicle's alignment specifications. Once the vehicle type is determined, the high tech and precise measuring begins.

Before attempting wheel alignment, make sure all steering-related and suspension-related parts are in good condition. It is impossible to properly align the wheels on a vehicle with worn or damaged parts.

1.2 Performing pre-alignment inspection

Before checking or adjusting the front-end alignment, the following items should be checked and corrected, if necessary, as part of the pre alignment checks:

1.2.1 Checking tire pressure and loading condition

The pressure when the tires are cold, as the friction from driving causes them to heat up and affects the pressure. Check them first thing in the morning or, if you're already driven the car, Consumer Reports recommends waiting at least three hours for the tires to cool down.

Figure 1-1Tires display tire inflation information on their sidewalls

Regardless of type, checking your tire pressure is a simple process. Remove the screw-on cap from the valve stem and press the gauge's fitting on the valve stem in a single, firm motion. The tire pressure will be displayed either on the stick, dial

indicator or digital readout of your pressure gauge. It's best to check tire pressure in the morning when the tires are cool. If you check tire pressure after driving, especially at higher speeds, the tires and the air in them can heat up and display a temporary increase in pressure.

A. Checking tire pressure

Importance of tire inspection

- Tires wear down.
- Air pressure decreases.
- It is possible that foreign substances such as pieces of metal may enter the tire as it contactsthe road surface.
- Inspection/Replacement interval

Wear

- Inspection: every 10,000km (6,000 miles) or 6 months
- Replace the tire when the tread depth of the tire wears below 3mm.
- If the depth of the tire tread reaches 1.6mm, the tire indicator appears on the tire surface and indicates the need for replacement. (It indicates the limit of tire wear.)

Air pressure

Inspection: every 10,000km (6,000 miles) or 6 months

• It is possible to judge by looking.

• It is possible to get a flat tire when the air pressure is abnormally low.

• Refer to the Owner's Manual for the prescribed air pressure.

• Check the spare tire at the same time as the tire inspection.

- **Condition of tire wear/uneven wear (Alignment):**

  When there is uneven wear such as both edge wear, center wear, feather wear, one side edge wear (inside or outside) toe and heel wear, or an abnormal wear, it is a sign that there is aproblem with the wheel alignment, not only with the air pressure.

B. Loading condition

Driving your vehicle in an overloaded condition is dangerous. Overloading causes excessive tire heat build-up and internal structural damage. This can cause a tire failure, even at a later date, which could lead to serious personal injury or death.

Figure 1-2 loading condition

Always keep the vehicle manufacturer's recommended inflation pressure in all your tires, including inside duals. Check their pressure at preventative maintenance intervals and during pre-trip vehicle inspections

1.2.2 Correcting tire and rim size

Tires are a part of the wheel setup. For instance, your vehicle has a set size of rims, but you can buy different sizes of tires to fit those rims, as long as the middle of the tires is the correct size.

With the wheel off the vehicle, make a chalk mark or index mark across the tire and rim. Then you can reinstall the tire in the same position on the wheel. To demount the tire, place the tire-and-wheel assembly on a tire changer. Remove the valve core and release the air from the tire. Remove any rim mounted wheel weights. Follow the tire-changer operating instructions to remove the tire from the rim. A typical procedure is to position the bead breakers (top and bottom) and loosen both tire beads from the rim flanges. Lubricate the inside of the wheel and the bead areas with nibbler lubricant. With the bottom tire bead in the wheel well place the tire iron under the top bead. Start the tire changer. As the finger rotates, the tire iron removes the top bead from the nm. As the tire iron rotates. The bottom bead is raised up. This frees the tire from the rim. If a rim is dirty or corroded or if the tire is not centered on the rim, the tire bead may bind" on the rim and refuse to seat. Allowing air pressure to build within the assembly in an attempt to seat the bead is a dangerous practice. Inflation beyond 40 psi (275 kPa.) may break the bead (or even the rim)

1.2.3 Measuring and Adjusting Ride Height

A. Measuring Ride Height

Suspension ride height should always be measured on the axle with the height control valve. There are two easy ways to measure suspension ride height:

- ✓ **Using a Hendrickson Ride Height Gauge**

Measure the distance between the axle and the mounting surface of the suspension. Ride height gauges work with both 5-inch and Large Diameter Axles. Ensure the proper scale on the ride height gauge is being used.

- ✓ **Using Tape Measure**

- Measure the distance from the top of the axle to the mounting surface of the suspension.
- Add half of the axle diameter to this measurement to determine the suspension's ride height.

- Adjusting Suspension Ride Height
- Disconnect the height control valve linkage at the lower bracket.

Push the height control valve arm up to raise the ride height (add air to the air springs) or down to lower the ride height (remove air from the air springs) until the distance between the suspension mounting surface and the center of the axle equals the designed ride height.

- **NOTE:** Ensure reservoir pressure is at a minimum of 90 psi. This ensures adequate pressure to open the pressure protection valve (PPV).
- **NOTE:** A delay of 5 to 10 seconds may occur before the height control valve allows air flow to or from the air springs.

✓ With the suspension at the proper ride height, lock the control arm in the neutral position by inserting the wooden centering pin through the control arm and into the hole in the valve body.

✓ Reconnect the height control valve linkage to the lower bracket. If necessary, adjust the linkage length so the control arm is held in the neutral position when the suspension is at the designed ride height.

✓ Remove the wooden centering pin.

1.2.4 Interpreting Results of Poor Alignment

The before column is the original measurement when the car came in. The Target Data column is what it should be. The Actual column should be what it is after the alignment.

The technician did make some changes, because the Actual data values are different than before values. However, while the front axle Toe values have been changed to match the target values, the rear axle Toe is still off. Both left and right are supposed to be 2.5mm. Left is correct, but Right is -1.7mm. That should be changed unless the rear axle doesn't have adjustment.

Basically, an alignment is trying to make sure that the wheels are in the proper position with each other and the car body and axles. You want the tires at a certain angle with the vertical and nearly parallel to each other.

If the alignment is off, you can get all sorts of strange things.

- Rapid tire wear. Especially on the front tires.
- Steering that feels like the car is wandering. Just can't get it to stay on the road.
- Steering that turns harder.
- Steering that feels out of control when taking a corner at higher speeds.
- Vehicle pulls to one side.

1.3 Testing vehicle to confirm need for alignment

Complaints of poor steering, ride and handling can be difficult to diagnose because of the complex relationships among a vehicle's steering system, suspension, alignment and wheels.

Problems with one system may be caused by another. The best way to find and correct a particular problem, as well as to find other problems or potential problems is using a checklist to inspect the entire steering and suspension system.

Excessive, erratic or unusual tire wear is the most common indicator of steering and suspension problems. The source of the problem may be as simple as improper tire inflation or as complicated as misaligned suspension geometry caused by an accident, component wear or improper repair. A test drive may be necessary to discover the cause of the complaint.

Check condition of suspension and steering systems

- **Steering**

Steering problems usually consist of handling difficulties, noises, hard steering or fluid leakage. During your inspection, pay close attention to the following items:

- ✓ **Check the power steering fluid level and type.** Improper fluid level or type may cause serious problems with the system, including the failure of the steering gear or the rack & pinion unit. Always follow the manufacturer's recommendation for power steering fluid.
- ✓ **Check the power steering pump shaft seal for signs of leakage.** If not corrected quickly, seal leaks will only get worse, causing the pump or gear to fail.
- ✓ **Check for leakage at all steering components,** including inside the bellows of the rack & pinion unit. Minor leaks that may be hidden within the bellows can become big leaks later.

- ✓ **Check the tension of the power steering pump belt.** If the pump isn't operating efficiently, steering will be difficult or erratic.
- ✓ **Raise the vehicle and check for excessive play**, travel, binding, wear or damage to all steering components. Don't forget to inspect steering wheel free play for excessive travel.

- **Suspension**

Suspension problems usually show up in the form of customer ride control complaints. Focus on the following areas:

- ✓ **Test the shocks by bouncing the vehicle at each corner.** If it bounces more than a couple of times, take a closer look at the shocks or struts. Although many techs don't use this test any longer, it can still be used to pinpoint problems on many vehicles.
- ✓ **Check the ride height** of the vehicle against the manufacturer's specification. If ride height is too low, fatigued or sagging springs may be the culprit.
- ✓ **Look for damage to the sway bar** due to hitting an object in the roadway or as the result of a collision. A deformed sway bar may cause minor alignment changes, which accelerate tire wear.
- ✓ **Check for looseness**. Most worn or damaged components can be found using this method.

Examine the suspension bushings for cracking, deterioration and wear.

- ✓ **Check ball joints for proper lubrication-both quantity and quality.** Always follow the specification for lubricant type and volume.
- ✓ **Check ball joint play.** Again, always use the measurement method recommended by the and consult a manual for the proper ball joint wear specs.
- ✓ **Inspect the shocks for damage and fluid leaks.** Check the seals for leakage and the piston rods for signs of damage and wear.

- **Tires and Wheels**

Uneven or unusual tire wear is normally an indication of steering or suspension problems, but may also be the result of improper tire inflation or structure, wheel bearing damage or wheel (rim) malformation. Make the following checks:

- ✓ **Inspect the tires for correct inflation pressure** and make sure they're all the same size. Heavy tread wear or low tire pressure can create hard steering. Different-size tires on the front wheels can throw the steering geometry off.
- ✓ **Inspect the wheel bearings for damage.** Slowly rotate the wheel manually and listen for a tell-tale "crunchy" sound. Severe damage may be felt through the tire.

If you follow these 5 easy steps to identifying if your car needs a wheel alignment.

Step 1: Eliminate Other Tire Issues.

Step 2: Inspect your Parked Alignment

Step 3: Check out the Tire Tread

Step 4: Give it a Quick Road Test.

Step 5: Take Your Car into a Trusted Auto Repair Center.

1.4 Interpreting manufacturer/component supplier specifications

Manufacturer specifications are an important element of cost and quality control for testing, calibration and other measurement processes. They are used for MTE selection or establishing equipment substitutions for a given measurement application. In addition, manufacturer specified tolerances are used to compute test uncertainty ratios and estimate bias uncertainties. MTE are calibrated periodically to determine if they are performing within manufacturer specified tolerance limits. In fact, the elapsed-time or interval between calibrations is often based on in-tolerance or out-of-tolerance data acquired from periodic calibrations. Therefore, it is important that manufacturer specifications are properly interpreted and applied.

Manufacturer's Specifications means (a) the written specifications, instructions or recommendations provided by the manufacturer of equipment or supplies that describe how the equipment or supplies are to be constructed, erected, installed, assembled, examined, inspected, started, operated, used, handled, stored, .

1.5 Alignment Angle Diagnostic Chart

An alignment chart as an icebreaker, to better understand your co-workers or other teams in your organization, or to plot out how customers will respond to something. The alignment chart has two axes: good versus evil and lawful versus chaotic.

A character with the "neutral" alignment is called a true neutral. An alignment chart is a grid that divides the alignments, usually for the purpose of putting descriptions or particular characters on it.

Self-check: 1
Directions:

Instruction: Discuss the following questions

1. List at least four Wheel alignment Pre-checks
2. Examine the suspension bushings for cracking, deterioration and wear.
3. What is the importance of tire inspection
4. How to check condition of suspension and steering systems
5. How we identify the condition of tire wear/uneven wear

Operation sheet 1:1

Operation Title: Check the condition of steering systems

Instruction:

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct inspection to check condition of steering systems

Required tools and equipment: wheel wrench, combination wrench, hammer, compressor, wire brush, screw driver, vise grips, wrench, hex or Allen key, socket wrench

Consumable Materials: Safety poster, first aid kit, waste bin, grease,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment's

Procedures:

Step 1: Check the power steering fluid level and type.

Step 2: Check for leakage at all steering components

Step 3: Check the tension of the power steering pump belt

Step 4: Check for excessive play

Quality criteria:

Perform all activities to check the condition of steering systems in accordance with the given procedures

Operation sheet 1:2
Operation Title: Check the condition of suspension systems

Instruction:

- ✓ systems Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct inspection to check condition of suspension

Required tools and equipment: Work area, tire pressure gauge, wheel wrench, combination wrench, hammer, compressor, wire brush, screw driver

Consumable Materials: Safety poster, first aid kit, waste bin, grease,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: Test the shocks by bouncing the vehicle at each corner.

Step 2: Check the ride height

Step 3: Look for damage to the sway bar

Step 4: Check for looseness

Step 5: Inspect the shocks for damage and fluid leaks

Step 6: Check ball joints for proper lubrication-both quantity and quality.

Quality criteria:

Perform all activities to check the condition of suspension systems in accordance with the given task

Operation sheet 1:3
Operation Title: Pre alignment Inspection

Instruction:

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct inspection to perform wheel alignment

Required tools and equipment: Work area, tire pressure gauge, wheel wrench, combination wrench, hammer, compressor, wire brush, screw driver

Consumable Materials: Safety poster, first aid kit, waste bin, grease,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: Verify that the fuel tank is full of fuel.

Step 2: Make sure all steering-related and suspension-related parts are in good condition

Step 3: Properly align the wheels on a vehicle with worn or damaged parts

Step 4: Visually inspect everything while the vehicle sits on the shop floor

Step 5: Reading tires involves inspecting the tire tread wear and diagnosing the cause

Step 6: Measure the ride height from the shop floor to specific points on the vehicle

Step 7: Check suspension fasteners for proper torque and retighten as necessary

Step 8: Load in the trunk takes weight off the front and changes caster and camber angles

Step 9: Inspect the underside of the vehicle with the vehicle raised

Step 10: Damaged parts must be repaired before adjusting alignment angles

Step 11: Road test the vehicle – check that the steering wheel is straight

Step 12: Feel for vibration in the steering wheel and floor of seats

Step 13: Notice any pulling or handling problems, and make sure the steering wheel is centered

Quality criteria:

Perform all activities to carryout pre alignment inspection in accordance with the given task

LAP Test

Practical Demonstration

Name: _____ **Date: _____**

Time started: _____ **Time finished: _____**

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 5 hours.

Task 1: Check condition of suspension and steering systems

Task 2: Pre alignment Inspection

Unit Two: Perform wheel alignment

This unit to provide you the necessary information regarding the following content coverage and topics:
• Types of wheel alignment • Calibrate Wheel Alignment Equipment • Measuring Alignment Geometry • Perform an Alignment This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Identify the types of wheel alignment • Calibrate Wheel Alignment Equipment • Using Measure Alignment Geometry • Performing an Alignment

2.1 Definition of wheel alignment

The driver can turn the automobile in any direction he desires by turning the steering wheel. However, if the driver had to continually manipulate the steering wheel to keep the vehicle running in a straight line when traveling on a straight road, or if he were required to expand a lot of energy to turn the vehicle on curves, he would be under a great physical and mental strain. The wheels are installed on the body at certain angles in accordance with certain requirements to eliminate these problems, as well as to prevent early wearing of tires.

These angles, in combination, are called “wheel alignment”. Steering is easy as long as the wheels are aligned properly, because the steering wheel will remain in a straight ahead position on straight roads with little help from the driver, and will require little effort to turn on curves. In other words, steering is easy when all of the elements that make up the angular relationship called “wheel alignment” are proper. But even one of these elements is incorrect, the following problems can occur:

1) Difficult steering
2) Poor steering stability
3) Poor recovery on curves

2.1.1 Purpose of wheel alignment

Alignment assures your tires meet the road at the proper angle, your wheels are pointing straight and your tires are centered in the wheel wells. It adjusts the angles of your vehicle's wheels to original specs for best gas mileage, proper road contact, a smooth ride, and the longest tire life.

2.2 Types of wheel alignment

There are 3 different types of wheel alignments you should know about; Front-end, Thrust and Four-wheel.

- ✓ **A front-end /center alignment**

Only measures and adjusts the front axle. It is sometimes done on vehicles with a solid rear axle and is the most basic alignment as it covers the bare minimum. Sometimes it is called a “toe-in” alignment or a “toe and go”. Toe-in means that the tires are pointing in towards each other.

The correct toe position for your vehicle will vary slightly depending on its suspension and on whether itis front-wheel, rear-wheel or all-wheel drive.

Many tire fitters consider a front-end only alignment unsuited to modern cars due to its incomplete nature and may refuse to offer it. Tire right recommend that you always have a Thrust or Four-wheel Alignment.

- ✓ **Thrust Alignment**

A thrust angle alignment ensures that all four wheels are "squared" with each other. It is recommended for all vehicles with a solid rear suspension, as it provides a better result on the road in terms of tire wear, fuel economy and safety. This is especially important if you are having an alignment completed after an accident or a hard knock to your suspension, such as running up a gutter.

- ✓ **Four-wheel Alignment**

All wheels are measured and corrected, resulting in a thrust angle at or near zero and a centred steering wheel. Two-wheel alignment equipment can be used to perform a four-wheel alignment by backing the vehicle onto the rack first and referencing and setting the rear wheels to the vehicle centreline. The vehicle is then turned around and the front wheels are referenced and corrected to the vehicle centreline.

The four-wheel alignment is for cars or 4WDs with four-wheel independent suspensions. It's also for front-wheel drive vehicles with adjustable rear suspensions. This type of alignment combines the elements of a front and thrust alignment but goes another step further by measuring and positioning the rear axle angles.

The four-wheel alignment will restore all four corners of your vehicle to the manufacturer's specifications. This type of alignment requires specialist equipment and is the most comprehensive alignment. It also results in the best overall handling for your vehicle and performance for your tires in terms of durability, fuel economy and safety.

2.3 Calibrating Wheel Alignment Equipment

Depending on your alignment equipment, enter the vehicle year, make, model and design into the system's computer to determine the alignment specifications. That data will be compared to the vehicle's actual alignment status to determine necessary corrections. Some systems allow you to simply scan the VIN to recall specs.

Next, drive the vehicle onto your alignment rack. Chock wheels and raise lift to a comfortable and safe work height, then lock the rack. Lift the vehicle by the centres jacks of the alignment rack, suspending the wheels. This will allow you to check tires for uneven, irregular wear, as well as to visually check the front-end and rear axle for any compromised suspension or steering components.

The machine is hooked up to a computer and your mechanic makes precise adjustments to a series of measurements to get everything perfectly aligned.

Using Alignment Equipment

Always follow the operating instructions provided by the manufacturer. Drive the vehicle up on the lift and carefully center the front tires on the turning radius gauges. Block the rear wheels. Mount the alignment heads on the wheels.

Turn on the alignment console and follow the computer prompts. After you identify the vehicle, the computer will retrieve stored data about performing an alignment on the vehicle. As you make adjustments, the equipment will monitor the changes in the alignment angles

Alignment Machines

The alignment machine consists of a rack, console, and related parts

- **Rack**
  - ✓ Consists of a lift, turning radius gauges, and equipment for measuring alignment angles
- **Console**
  - ✓ Consists of a color monitor, keypad, and computer. It provides training, instructions, specifications, and feedback when doing wheel alignment
- **Software**
  - ✓ Alignment equipment software contains computer instructions, equipment operating instructions, and alignment specifications.
  - ✓ When installed in the computer, the software will help you adjust all alignment angles quickly and easily.
  - ✓ Usually stored on a CD-ROM

Figure 2 1 Wheel machine operation

- **Alignment Heads**
  - ✓ Mount on the vehicle's wheels
  - ✓ Brackets are used for mounting the alignment heads on the wheels
  - ✓ Use lasers or proximity sensors to compare the alignment of each wheel
  - ✓ Used to check caster, camber, and toe

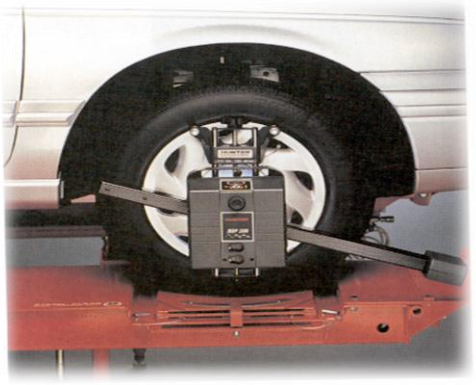

Figure 2 2 Alignment heads

- **Turning Radius Gauges**

Measure how many degrees the front wheels are turned right or left. This gauge commonly used when measuring caster, camber, and toe-out on turns.

The gauges may be portable or mounted on the alignment rack. Centre the front wheels of the vehicle on the turning radius gauges. Pull out the locking pins so the gauge and tire turn together. The pointer on the gauge will indicate how many degrees the wheels have been turned.

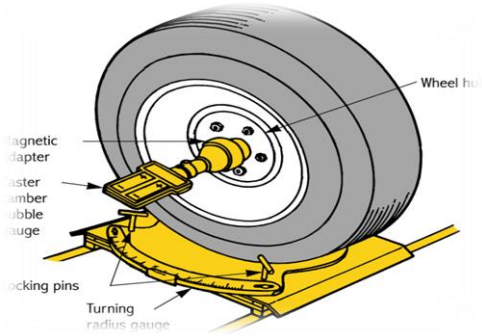

Figure 2 3 Turning Radius Gauges

2.4 Measuring Alignment Geometry

2.4.1 Camber and Caster

The front wheels of the care are installed with their tops tilted outward or inward. This angle is called "camber" and is measured in degrees of tilt from the vertical. When the top of a wheel is tilted outward, it is called "positive camber". Conversely, inward inclination is called "negative camber".

Tire wearing angle – wear occurs on the side to which the wheel leans (on the outer or the inner area of the tread). The proper camber setting will correctly load the suspension and minimize tire wear. It is measured in degrees of a circle, with zero degrees at true vertical.

If the wheel leans in towards the chassis, it has negative camber; if it leans away from the car, it has positive camber. In modern automobiles, the suspension and axles are stronger than in the past and road surfaces are flat, so there is less need for positive camber. As a result, tires are being adjusted more toward zero camber (and there are some vehicles with zero camber). Some models are even being given negative camber to improve cornering performance.

The roles of positive camber

1) Reduction of vertical load
2) Prevention of wheel slip off
3) Prevention of undesirable negative camber due to load
4) Reduction of steering effort.

Purposes of Camber

- ✓ Prevent tire wear on the outer or the inner tread
- ✓ To load the larger inner wheel bearing
- ✓ To aid steering by placing the vehicle's weight on the inner end of the spindle

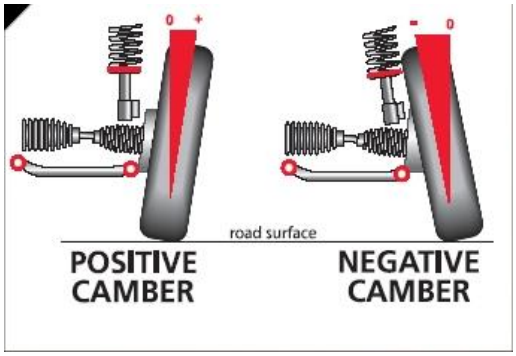

Figure 2 4 Camber types

Caster

Caster is forward or rearward tilt of the steering knuckle away from true vertical. Viewed from the side, a line drawn through the upper and lower ball joints describes the caster angle. On a MacPherson strut system, the caster is a line through the upper strut mount and lower ball joint.

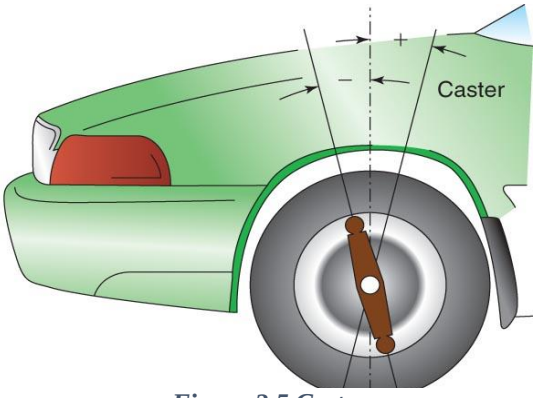

Figure 2 5 Castor

If the top of the line tilts rearward, the vehicle is said to have "POSITIVE" caster. If the top of the line tilts forward, the vehicle is said to have "NEGATIVE" caster. By setting the caster angle on the driver's side ½ degree less than the passenger side for positive caster specifications or 1/2 degree more for negative caster specifications, the road crown should not cause vehicle pull in either direction.

Caster is designed to provide steering stability. The caster angle for each wheel on an axle should be equal. Caster is affected by worn or loose ball joints, strut rods, and control arm bushings.

Purposes of Caster

- ➢ Aid directional control
- ➢ Cause the wheels to return to the straight-ahead position
- ➢ Offset road crown pull (steering wheel pull caused by the hump in the center of the road)
- ➢ Directional control

- Steering return ability

Positive Caster

- Tilts the top of the steering knuckle toward the rear of the vehicle
- Helps keep the wheels traveling in a straight line
- When the wheels are turned, it lifts the vehicle
- The vehicle's weight tends to push the wheels back to the straight-ahead position

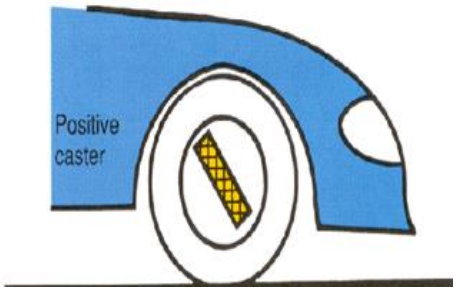

Figure 2 6 Positive Castor

Negative Caster

- Tilts the top of the steering knuckle toward the front of the vehicle
- The wheels will be easier to turn
- The wheels will tend to swivel and follow imperfections in the road

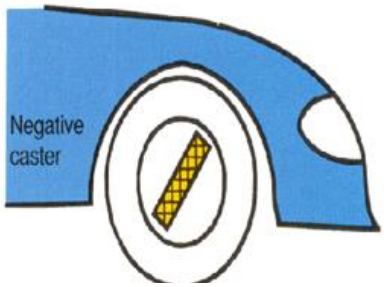

Figure 2 7Negative Caster

2.4.2 Toe-in and Toe-out

Toe is the difference in distance between the front and rear of the tires. When the tires are closer together at the front than at the rear, the wheels are said to be toed in, and if they are farther apart at the front, they are toed out. Toe-in is also called positive and toe-out negative.

• The most critical tire wearing angle, because if toe is outside of specs, excessive tire wear will quickly result, due to scuffing, as the tire tends to be dragged sideways on the road while it rolls.

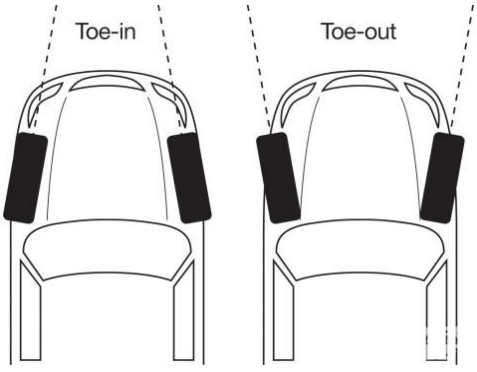

Figure 2 8 Toe-in and Toe-out

• Measured in fractions or decimals of an inch, in millimetres, or degrees

Toe-in: wheels are closer at the front than at the rear

Toe-out: wheels are farther apart at the front than at the rear

When the front of the wheels are closer together than the tear of the wheels (as viewed from

above), this is called “toe in”. The opposite arrangement is called “toe out”. Toe angle is usually expressed by a distance (B-A).

Roles of toe angle

1) Cancel out the camber thrust generated when camber is applied.
2) Straight-line stability due to side thrust force.

2.4.3 Included Angle and Steering Axis Inclination (SAI)

The axis around which the wheel rotates as it turns to the right or left is called the “steering axis”. This axis is found by drawing an imaginary line between the top of the shock absorber’s upper support bearing and the lower suspension arm ball joint (in the case of strut type suspensions).

This line is tilted inward as viewed from the front of the car and is called the “steering axis inclination (S.A.I.)” or “kingpin angle”. This angle is measured in degrees. Furthermore, the distance between the intersection of the steering axis with the grind and the intersection of the wheel centerline with the ground is called the “offset” for “scrub radius”.

A. Roles of steering axis inclination

1) Reduction of steering effort
2) Reduction of kickback and pulling to one side
3) Improving straight-line stability

The angle, away from true vertical, formed by a line drawn through the ball joints (or the lower ball joint and the upper strut mount on MacPherson strut systems)

• The SAI is always an inward tilt.

• SAI is neither a tire wearing angle nor adjustable. It is designed into the suspension system.

• The combination of the SAI and camber is called the included angle.

• Incorrect SAI can prevent proper camber adjustment, and can be caused by bent components.

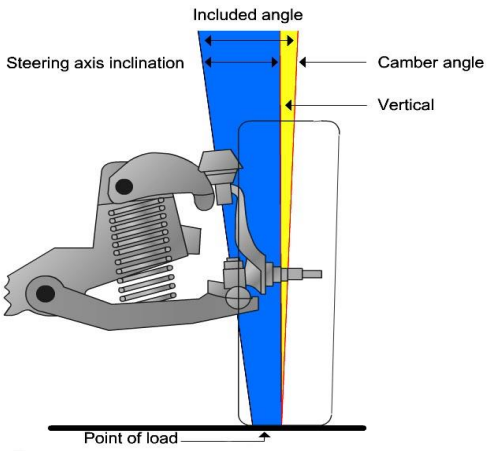

Figure 2 9 Steering axis inclination

B. Purposes of steering axis inclination

SAI helps return the steering to straight ahead after a turn and keeps the vehicle going straight with little steering wheel correction needed. As the wheel is turned, the geometry created by the SAI causes the outer spindle to attempt to swing in a downward arc. This forces the weight of the vehicle to be lifted. The weight of the vehicle tends to return the wheels to the straight ahead position and keep them there.

2.4.4 Scrub and Turning Radius

A. Scrub

The distance between where the SAI line meets the road and the centre line of the tire. It is the turning pivot area for the tire's contact patch on the road. If the scrub area is inboard of the center line, it is said to be a positive scrub radius, and if it is outside of the centre line, it is said to be a negative scrub radius. A few have been designed with a scrub radius of zero, but stability and handling are generally better and more consistent when a scrub radius is somewhat positive or negative, and better tire wear also results.

• Too much positive scrub radius increases steering effort and too much positive or negative scrub radius can adversely affect vehicle handling, stability and braking.

• The proper amount of scrub radius is designed into the suspension, wheels, and tires by the manufacturer.

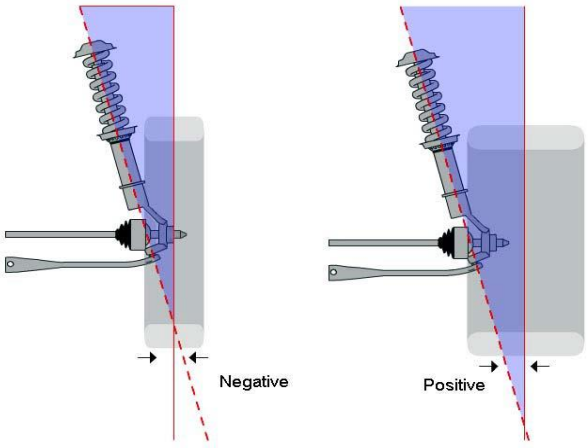

Figure 2 10 Scrub radius

The scrub radius is the distance in front view between the king pin axis and the center of the contact patch of the wheel, where both would theoretically touch the road. It can be positive, negative or zero.

The kingpin axis also known as steering inclination is the line between the upper and lower pivot points of the steering knuckle.

If the kingpin axis intersection point is outboard of the center of the contact patch, it is negative; if inside the contact patch, it is positive. The term scrub radius derives from the fact that either in

the positive or negative mode, the tire does not turn on its centerline (it scrubs the road in a turn) and due to the increased friction, more effort is needed to turn the wheel.

Large positive values of scrub radius, 4 inches/100 mm or so, were used in cars for many years. The advantage of this is that the tire rolls as the wheel is steered, which reduces the effort when parking, provided you're not on the brake.

The advantage of a small scrub radius is that the steering becomes less sensitive to braking inputs. More scrub radius adds to road feel by pushing the inside wheel into the ground.

B. Turning Radius

When turning a corner, the outer wheel must travel a greater distance than the inner wheel, so it follows a wider arc. The inner wheel must turn more sharply, and so a toed out condition is necessary to eliminate tire scrubbing and squealing. Toe-out on turns provides better traction and reduces tire wear when cornering.

The turning radius, or toe-out on turns, is the amount the front wheels toe out when turning. Also called the Ackerman angle, the different turning radius angles are built into the inward angle of the steering knuckle arms and are not adjustable.

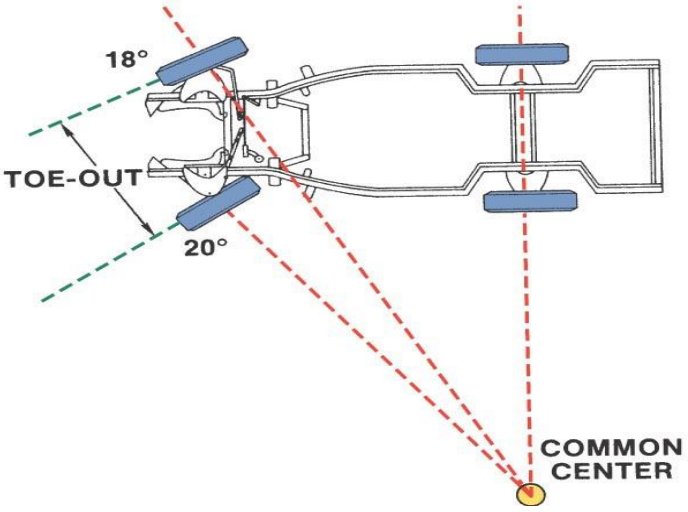

Figure 2 11 Turning Radius

C. Tracking (Thrust Angle)

Tracking is the relationship of the rear wheels to the front wheels. In a properly aligned vehicle, the rear wheels follow directly behind the front wheels. On rear-wheel drive vehicles, the rear wheels will be parallel with an imaginary line drawn through the centres line of the vehicle. On front-wheel drive vehicles, the rear wheels will be parallel or nearly parallel with the centres line, with equal individual toe.

The thrust line is a line that is projected forward, perpendicular to the axle line of the rear wheels (whether or not there is actually a straight axle). On front-wheel-drive vehicles, the thrust line is an average determined by measuring the individual rear toe. The difference between the centres line and the thrust line is the thrust angle. On a properly aligned vehicle, the center line and the thrust line are both straight ahead and the thrust angle is zero.

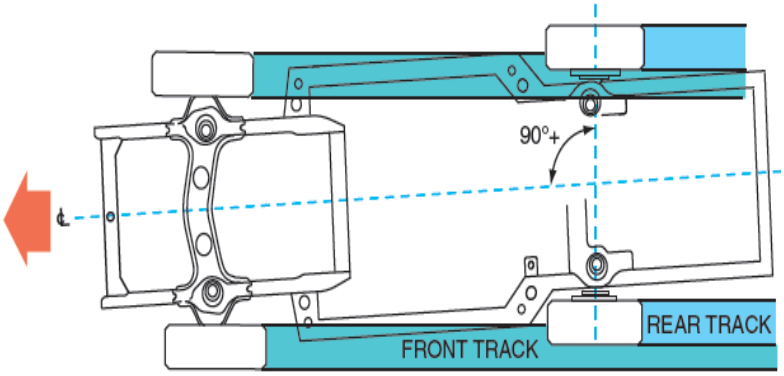

Figure 2 12 Tracking (Thrust Angle)

2.4 Performing an Alignment

2.4.1 Machine Care

- Two machines are connected by a rotary axis
- A rotary drive unit is installed inside or connected to a machine
- Several rotary drive units are connected in cascade.

Even when using flexible couplings a precise alignment stays very important! While misalignment has no measurable effect on motor efficiency, correct shaft alignment ensures the smooth, efficient transmission of power from the motor to the driven equipment. Incorrect alignment occurs when the centerlines of the motor and the driven equipment shafts are not in line with each other.

2.4.2 Gauges and miscellaneous Tools

Gauges are used to measure different types of objects having various sizes, shapes, and thicknesses, the gap in space, diameter of materials, or pressure of the flow. Specific types of gauges are used to measure each parameter. Gauges are classified into eight types, they are: Plug gauge. In addition there is a miscellaneous tools Vacuum cleaner dry / wet, Wrenches. Sockets, Wallet roll, Drill bits, Pliers and Rivets.

2.4.3 Interpreting Specification

The vehicle manufacturers' alignment specifications usually identify a "preferred" angle for camber, caster and toe (with preferred thrust angle always being zero). The manufacturers also provide the acceptable "minimum" and "maximum" angles for each specification.

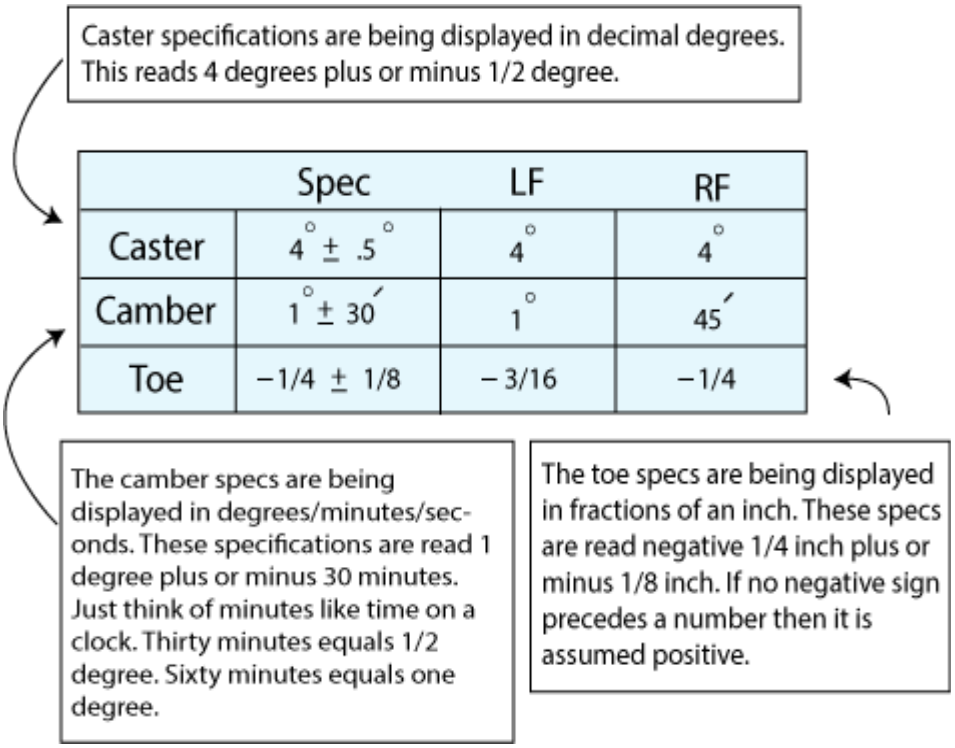

Figure 2 13 Interpret manufacturer specification

For a normal car you typically want to maintain a slight amount of negative camber (0.5 - 1°) to have a good balance of cornering grip, braking grip, and tire wear. On most vehicles it's common to have slightly more negative camber (**0.8 - 1.3°**) in the rear to reduce the chances of over steer (loss of grip in rear). When the tires on your car are angled the same way (remember, we're thinking in terms of birds-eye-view), we call this toe-in alignment. Angle your feet outward and you have toe-out alignment.

2.4.4 Adjusting Caster and Camber

Front Caster & Camber Adjustment

1. Caster is relative to frame, the caster values must be compensated for the measured frame angle by using a digital protractor or equivalent on a flat portion of the frame in front of the rear tire.

2. Frame angle is positive when higher in the rear. Measure both sides of the frame and take an average from those measurements. Then add the average frame angle to the caster reading when making adjustments.

3. Frame angle is negative when lower in the rear. Measure both sides of the frame and take an average from the measurements. Then subtract the average frame angle from the caster reading when making adjustments.

4. The caster and camber adjustments are made by rotating the offset cam bolt and the cam in the slotted frame bracket in order to reposition the control arm

With front-end alignments, correct caster and camber adjustments first. Certain FWD vehicles do not offer caster adjustments, but correcting the camber may bring the caster within specs.

NOTE: Before adjusting the caster and camber angles, jounce the front bumper three times to allow the vehicle to return to normal height. Measure and adjust the caster and the camber with the vehicle at curb height.

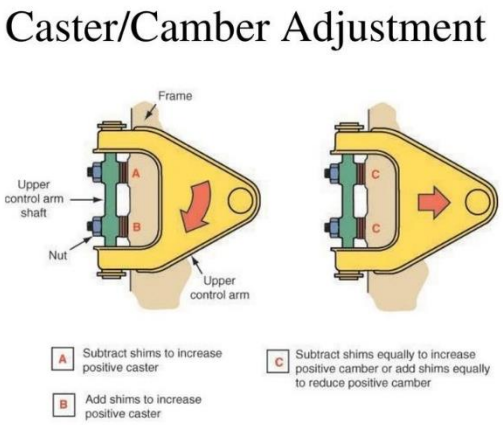

Figure 2-1 Camber caster adjustment

2.4.5 Toe Adjustment

Adjust the toe by turning the inner tie rod on a rack and pinion steering system and by turning the adjusting sleeve on a parallelogram linkage system. To adjust the toe on a vehicle with a typical rack and pinion system, loosen the nut on the inner tie rod about a half-inch from the outer tie rod end.

Toe, or tracking, is when a car's wheels point to the right or left side in an asymmetric angle. Toe-in, also known as positive toe, refers to front of the wheels tilting towards the centerline of a vehicle, while toe-out, or negative toe, and is when the front of the wheels tilt outwards. Toe is one of the three major alignment configuration parameters in a car. It is a basic setting that has a considerable impact on a car's directional stability and tire wearing angle. It also changes according to a vehicle's speed.

A. Effects of Toe

Toe-in effects are mostly provided for rear-wheel drive cars, trucks, and SUVs, as this offers better straight line stability. The downside is that turning response is a bit more sluggish. When navigating a sharp corner, toe-in changes to toe out to reduce tire scrub, because the inside wheel turns through a small interval compared to the outside wheel.

The majority of rear-wheel-drive cars use positive toe-in to enable tires to move appropriately and to make up for rearward movement caused by tire rolling resistance. When a vehicle has a lot of toe ins, the outside edges of the tires wear out quickly; thus, toe-in is only required in a small amount to enable the vehicle to gain more stability and compensate for slight changes in geometry and suspension height.

B. Toe-Out Effects

Toe-out effects are mostly found in race cars as the vehicles require a very responsive steering system. Whether you attend an event at a small local racetrack or the Nurburgring, many cars will be set up with some toe-out.

The majority of four-wheel drive cars are fitted with toe-out systems that help with a quick and more effortless steering response. Toe-out setting on front-wheel drive vehicles makes the front tires stronger and increases grip, which helps with acceleration. However, the tire span decreases due to increased pressure on the rubber.

When a car is about to move or is navigating a rough road, front-toe wheels help the vehicle to achieve directional stability. They offer a natural steering wheel stability when the driver is about to take a turn. Front-wheel drive vehicles use negative toe-out to avoid forward movement and enable tires to move side by side at a relatively good speed.

Figure 2 14 Toe tester

2.4.6 Rear-Wheel Adjustments

The most common layout for a rear-wheel drive car is with the engine and transmission at the front of the car, mounted longitudinally.

Other layouts of rear-wheel drive cars include front-mid engine, rear-mid engine, and rear-engine.

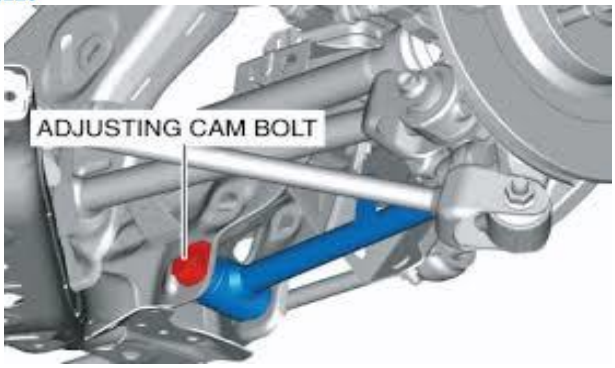

Figure 2 15 Rear-Wheel Adjustments

Rear-Wheel Symptom

- Uneven or rapid tire wear.
- Steering wheel being crooked when you are driving straight.
- Noisy Steering.
- Pulling to the right or left.
- Squealing tires.

Self-check 2

Name…… ID…… Date…….

Directions: choose the best answer

1. What is the most important alignment angle in terms of tire wear?

A. Camber B. Caster C. Toe D. Steering axis inclination

2. When performing a four wheel alignment, always start by:

A. Checking the tire pressure of all four tires
B. Checking the pressure and condition of the tires on the rear axle
C. Rotating all four tires
D. All of the above
E. A and C only

3. Caster adds directional stability to a vehicle. Too much positive caster can cause:

A. Loose steering
B. A squealing noise around turns
C. Quick braking action
D. Hard steering

4. What is the most important alignment angle in terms of tire wear?

A. Camber. B. Toe. C. Caster. D. Steering axis inclination.

5. A vehicle's steering parts are wearing out prematurely. A likely cause is:

A. Incorrect camber
B. Incorrect caster
C. Incorrect toe
D. All of the above
E. B and C only

6. Toe-out is:

A. Means the front of the tires are closer together than the rear of the tires
B. Means the front of the tires are farther apart than the rear of the tires
C. Corrects the tendency of the wheels to deflect out while in motion
D. Isn't affected when suspension height is changed

7. Benefits of a four wheel alignment include:

A. Increased tire life
B. Increased fuel economy,
C. Increased turning angle
D. All of the above

8. The tires on a motor home have an abnormal wear pattern. All you can suggest to your customer is:

A. Adjust positive camber
B. Buy new, bigger radial tires
C. Keep tires properly inflated, rotate them on schedule, and check the alignment
D. Replace the tire

Operation sheet: 2.1

Operation Title: Adjust the Camber Alignment

Instruction:

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct adjustment to the camber Alignment

Required tools and equipment: Tape measure**,** a spool of string, four jack stands, Camber gauge, 24mm wrench or adjustable wrench, 13mm wrench, Control arm shims

Consumable Materials: Safety poster, first aid kit, waste bin, grease,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: Attach the camber gauge to the center of your tire.

Step 2: Adjust the gauge until it shows that it is straight.

Step 3: Remove the tire.

Step 4: Locate the upper control arm**.**

Step 5: Use a wrench to adjust it however many degrees is necessary

Step 6: Insert an equal number of shims on frame rail and cross-shaft mounting bolts.

Quality criteria:

Perform all activities to adjust the camber Alignment in accordance with the given task

Operation sheet: 2.2
Operation Title: Adjust the Caster Alignment

Instruction:

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct adjustment to the caster Alignment

Required tools and equipment: Tape measure**,** a spool of string, four jack stands, Camber gauge, 24mm wrench or adjustable wrench, 13mm wrench, Control arm shims

Consumable Materials: Safety poster, first aid kit, waste bin, grease,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: Place the wheel back on.
Step 2: Adjust the tire inward 20 degrees**.**

Step 3: The camber gauge should have **a** caster adjustment knob. .

Step 4: Move the tire 20 degrees outward.

Quality criteria:

Perform all activities to adjust the caste alignment in accordance with the given task

Operation sheet: 2.3
Operation Title: Adjust the Toe Alignment

Instruction:

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct adjustment to the Toe Alignment

Required tools and equipment: Tape measure**,** a spool of string, four jack stands, Camber gauge, 24mm wrench or adjustable wrench, 13mm wrench, Control arm shims

Consumable Materials: Safety poster, first aid kit, waste bin, grease,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: Center the steering wheel and lock in place using a steering wheel clamp.

Step 2: Loosen front inner to outer tie rod end jam nuts.

Grasp inner tie rods at secretions and rotate inner tie rods of steering gear to set front toe to the preferred toe specification**.**

Step 3: Tighten tie rod jam nuts to 75 Nm (55 ft. lbs.) torque.

Step 4: Adjust steering gear to tie rod boots at the inner tie rod.

Step 5: Remove steering wheel clamp.

Step 6: Remove the alignment equipment.

Step 7: Road test the vehicle to verify the steering wheel is straight and the vehicle does not wander or pull.

Quality criteria:

Perform all activities to adjust the Toe Alignment in accordance with the given task

LAP Test 2

Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

Task 1: Adjust the Camber Alignment

Task 2: Adjust the Caster Alignment

Task 3: Adjust the Toe Alignment

Unit Three: Cleanup work area and maintain equipment

This unit to provide you the necessary information regarding the following content coverage and topics:

- Removing waste and scrap
- Identifying and tagging faulty tools and equipment

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Remove waste and scrap
- tagging faulty tools and equipment

Cleanup work area and maintain equipment

We focus on handling all your automotive workshop and showroom cleaning requirements, so you can focus your resources on other aspects of your business. With our advanced technology and chemicals, you can enhance your efficiency, profitability, and production.

1. We service most brands of cleaning equipment and have preventative maintenance options for most requirements.
2. We have a wide range of equipment specifically designed for the automotive industry.
3. We provide training and consultation.
4. We are truly a one stop shop for the Automotive Industry. we have cleaning solutions in the Automotive and Workshop Industry for:
    - Workshops
    - Heavy Equipment Maintenance
    - Retail Showroom
    - Distribution & Logistics
    - Car Parking & Open Spaces
    - Office & Corporate

The cleaning principles are:

- Dry clean. Remove visible and gross soils and debris.
- Pre-rinse. Rinse all areas and surfaces until they are visibly free of soil.
- Wash (soap and scrub).
- Post-rinse.
- Inspect.
- Sanitize. .
- Dry.
- Verification

3.1 Removing waste and scrap

Waste management (or waste disposal) includes the processes and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms.

Ways to Reduce Waste

- Use a reusable bottle/cup for beverages on-the-go.
- Use reusable grocery bags, and not just for groceries.
- Purchase wisely and recycle.
- Compost it!
- Avoid single-use food and drink containers and utensils.
- Buy secondhand items and donate used goods.

3.2 Identifying and tagging faulty tools and equipment

Easily and quickly identify assets and equipment which is defective with our Defective Equipment Tag. Yellow to indicate 'precaution' with added detail; by whom and when. Double sided to add additional remarks and clear information. Hole punched to allow easy cable tie attachment. Utilize with fine nibbled permanent marker pen for durability. Space for logo / location or contractor information. Can be customized. Ultra-tear-resistant and have been proven to withstand some of the harshest environments.

Figure 4-1 Tagging

3.2.1 Inspect and tag equipment

Preventing the breakdown of a machine is much better than having to fix it after the event. A lot of time and money is spent on setting up an effective preventative maintenance schedule to avoid breakdowns. However, even with the best preventative maintenance program in the world, breakdowns will occur. When this happens qualified maintenance personnel are usually called in to make any repairs.

The first step towards maintaining an effective preventative maintenance program is to have a running maintenance program and reporting procedures in place. An important part of any running maintenance program is identifying faults and using an appropriate sign system, called tagging, on faulty machines and equipment.

Figure 4-2 Scaffold Tags

3.2.2 Identifying problems

Identifying faulty equipment and machinery is part of both preventative and running maintenance. Problems are considered to be either major or minor. Deciding what kind of problem exists will determine what kind of maintenance needs to be carried out.

A. Major problems

Major problems are all maintenance tasks that need specialist maintenance personnel to fix them. The problem may be a complete breakdown or an occasional malfunction. If you think that a major problem exists there is usually a procedure to follow for reporting the problem.

B. Minor problems

Minor problems do not require specialist personnel. Machine operators or other trained staff are usually able to deal with them. A minor problem may be present if:

- ✓ The machine operates but production levels are reduced, or
- ✓ The quality of output is affected.

Waste disposal methods

- ✓ Recycling. Incineration.
- ✓ Other thermal treatment plants. Chemical-physical and biological treatment.
- ✓ Chemical-physical and biological treatment. Landfills.
- ✓ Landfills. Collection and logistics.

Defective Equipment Tags prevent dangerous accidents.

Make sure that defective equipment doesn't endanger your employees. Instead, use our tags to isolate defective equipment.

Defective Equipment tags are packaged in our Tags-on-a-Roll tag dispenser for effortless handling and mess-free storage.

Our best-in-class self-laminating Deficiency Tag gives an incredible range of labor saving features. Each tag has a paper copy that can be used for your office records. This paper copy and base tag are both numbered, for easy tracking. And, best of all, the tag features a self-laminating flap that seals in our writing and makes it weather and tamperproof. No tag is more durable and traceable.

Equipment Fault refers to condition when the Contract Equipment (incl. parts, raw materials, cast and forged parts, original parts, etc) cannot meet the performance and quality criterion specified in the Contract and/or cannot satisfy the requirement of project stability, reliability, safety and economic operation.

Figure 4-3 Scaffold Tags

An effective lockout/tag out program will help prevent:
Contact with a hazard while performing tasks that require the removal, by-passing, or deactivation of safeguarding devices.

Purpose of a lockout/tag out program

- ✓ Hazardous energy in the workplace.
- ✓ Energy-isolating devices.
- ✓ De-energizing devices.

Self-check 3

Name…… ID…… Date…….

Directions:

Instruction I: Choose the Best Answer

1) Identifying faulty equipment and machinery is part of both preventative

A. Identifying Problems B. Major Problems C. Waste Disposal Methods D. all

2) 2._____ other thermal treatment plants. chemical-physical and biological treatment.

A. Identifying Problems B. Major Problems C. Waste Disposal Methods Dall

3) _____minor problems do not require specialist personnel. machine operators or other trained staff

A. Identifying Problems B. Major Problems C. Waste Disposal Methods Dall

4) Purpose of a lockout/tag out program

A. Hazardous energy in the workplace.
C. De-energizing devices.
B. Energy-isolating devices.
D. None

5) The quality of output is affected.

A. Major problems
B. Minor problems

Instruction II: Give Short Answer

1) _____ includes the Processes and actions required to manage waste from its inception to its final disposal
2) _____the Purpose of a Lockout/Tag out Program
3) _____ Waste disposal methods

Operation sheet 3.1

Operation Title: Removing waste and scrap

Instruction:

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct Cleanup work area and maintain equipment

Required tools and equipment: wheel wrench, combination wrench, hammer, compressor, wire brush, screw driver, vise grips, wrench, hex or allen key, socket wrench

Consumable Materials: water, first aid kit, waste bin,

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free

Procedures:

Step 1Dry clean. Remove visible and gross soils and debris.

Step 2Pre-rinse. Rinse all areas and surfaces until they are visibly free of soil.

Step 3Wash (soap and scrub).

Step 4Post-rinse.

Step 5Inspect.

Perform all activities to check the condition of steering systems in accordance with the given procedures

LAP Test 3

Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

Task 1: Creating Safe working area

Task 2: Order properly operated tools and equipment

Task 3: Cleanup work area and maintain equipment

Reference

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