

ACADEMY / STUDY BOOK

Wheel Alignment Fundamentals

Prepare the vehicle and alignment equipment, interpret toe, camber, and caster readings, and verify adjustments against specifications.



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How to use this book

Read the lessons, work each example, then complete the practice questions before checking the answer explanations. Write your evidence and next step in the exercises. Training examples are not vehicle service specifications.

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Before you begin

Basic steering and suspension knowledge. Equipment operation requires supervised, vehicle-specific training.

Learning objectives

- Distinguish toe, camber, caster and thrust angle by viewing direction.
- Check setup before interpreting a measurement.
- Calculate total toe and compare signed readings with a supplied range.
- Build a before-and-after record without concealing a mechanical defect.

Course contents

Prepare a vehicle that can be measured accurately

Read the angles and their units

Interpret an alignment report before adjusting

Adjust, verify and explain limitations

Worked shop cases / Practical worksheet / Practice assessment / Answer explanations / Further study

Prepare a vehicle that can be measured accurately

An alignment machine reports geometry; it cannot decide whether the vehicle was prepared correctly. Start with the VIN, suspension option, wheel and tire sizes, ride-height requirements, and current service information. Selecting a similar model can produce a convincing green screen against the wrong specification. Record the exact selection before measuring.

Check cold pressures against the applicable placard or approved fitment guidance. Inspect tires and wheels for damage, mismatched sizes, unusual wear and runout. Record loading, fuel level or ballast where the procedure specifies them. Measure ride height at the specified points: a body-panel gap is not automatically the correct reference. A sagged spring or extra cargo can change measured angles.

Inspect steering and suspension joints in their required loaded or unloaded state. Excess play prevents a repeatable adjustment; tightening an adjuster will not repair a loose joint. Check rack capacity and safe access, then follow the alignment equipment instructions for target attachment, compensation, turn plates and slip plates. Compensation accounts for mounting/runout effects; it is not wheel balancing.

Worked setup decision

A vehicle has a pull and a low right-front tire. Its initial alignment shows uneven camber. Correct and investigate the pressure loss, establish the specified load and ride height, inspect for play, and remeasure. Do not use an adjustment to compensate for an uncontrolled setup variable.

Before you continue

Write down vehicle selection, tire pressures, load condition, ride height, inspection findings and compensation status. If any required condition is unknown, the readings are provisional-not a completed diagnosis.

Separate repeatability from accuracy

A machine can repeat the same number while comparing it with the wrong vehicle specification. That is repeatable but not a valid service decision. Conversely, correct specification data do not make unstable readings trustworthy. Check both the reference and the measurement conditions. Record suspension option, load state, tire condition, ride height and relevant equipment setup so a second technician can reconstruct the test.

Think of the vehicle, rack, targets and procedure as one measuring system. A target moved during the job, an unlocked mounting device, a plate that cannot move as required or a loose joint can undermine the result. When an unexplained change appears, return to the setup instead of chasing the reading with another adjustment. Document which condition changed and repeat the affected step under the equipment instructions.

Complaint interview

Ask whether the steering wheel is off-center when travelling straight, the vehicle drifts when the wheel is released under safe test conditions, or the driver feels a vibration. Those are not interchangeable complaints. Ask about recent impacts, tire changes and suspension work without assigning blame. Record road and load conditions. A customer saying “it needs an alignment” is requesting help with a concern; it does not establish that alignment is the only cause or cure.

Treat setup as part of the measurement

A convincing alignment report begins before the display turns green. Identify the vehicle and suspension configuration, confirm the applicable specifications, inspect the condition that could prevent repeatable measurement, and establish the required loading and ride-height conditions. Follow the equipment instructions for target mounting, compensation and plate operation. An incorrect setup can produce precise-looking numbers that are not valid for the job.

Imagine a customer installed cargo equipment and arrives with a full load. The correct response is not to assume unloaded specifications still apply or remove arbitrary weight until readings improve. Establish the vehicle's required measurement state and document how it was achieved. If a required condition cannot be met, explain the limitation and obtain direction before treating the printout as a final alignment result.

A trustworthy alignment baseline

- Identify Correct vehicle and suspension specification
- Inspect Tires, mechanical condition and ride height
- Set up Loading, targets and compensation
- Record Initial readings and measurement conditions

Try it before reading the answer

The report uses the correct model year but the wrong suspension option. Can the existing green bars be accepted?

Worked answer and reasoning

No. Select the applicable vehicle configuration, verify the required setup and reevaluate the measurements. The displayed pass/fail state is meaningful only relative to the right reference. Do not average specification ranges or select a broader option merely to obtain a pass.

Read the angles and their units

Toe is the direction a wheel points when viewed from above. Toe-in means the front edges are closer together than the rear edges; toe-out means the opposite. Individual toe describes one wheel relative to the machine reference. Total toe is the signed sum for the axle. Verify whether the display uses decimal degrees, degrees and minutes, or a distance unit; they cannot be substituted without the proper conversion and wheel reference.

Camber is wheel tilt viewed from the front or rear. Top outward is positive; top inward is negative under the usual convention. Caster is steering-axis tilt viewed from the side, not wheel tilt. With the vehicle front identified, a steering axis whose upper point is rearward has positive caster. Some vehicles do not provide routine adjustment for every angle.

Thrust angle describes rear axle travel direction relative to the vehicle centerline. Front readings and steering-wheel position must be interpreted with rear geometry, not in isolation. A pull can also involve tires, road crown, brake drag, loading or damage. No one angle proves the cause of every complaint.

Read the numbers

Training-only example: left toe $+0.08^\circ$, right toe $+0.12^\circ$. Total = $+0.20^\circ$. If the supplied total range is $+0.10^\circ$ to $+0.30^\circ$, total is in range. That does not prove that individual angles, steering center or thrust angle are acceptable. Also, $0^\circ 30'$ equals 0.50° , not 0.30° : there are 60 minutes per degree.

Use the diagram with the viewing direction stated aloud. Describing caster from a front-view wheel sketch is a common misunderstanding. These examples teach interpretation, not universal adjustment targets.

Choose the viewing direction first

Imagine looking down on two front wheels: you can compare where their leading edges point, which describes toe. Now stand conceptually in front of the vehicle: the wheel tops lean toward or away from the center, which describes camber. Finally, look from the side and identify the upper and lower steering-axis pivots: their fore-aft relationship describes caster. Caster is an axis angle, not the visible lean of a wheel in a front photograph.

Under the usual sign convention, positive caster places the upper pivot rearward relative to the lower pivot. Camber is positive when the wheel top leans outward. Equipment displays can define cross-angle subtraction differently, so write the formula before calculating. Individual toe values use a reference established by the machine and procedure. Do not substitute a centerline assumption for that reference.

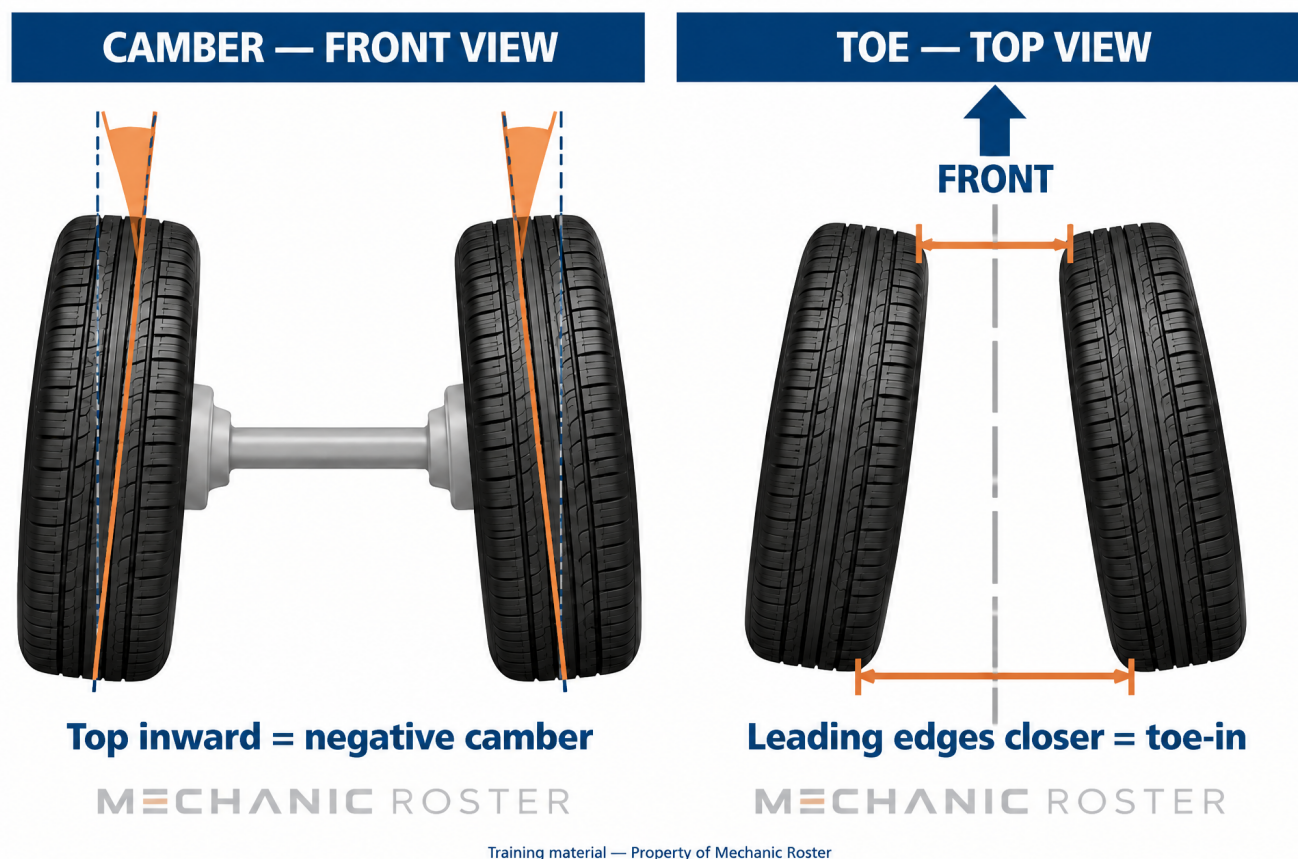
Unit conversion exercise

Decimal degrees use a decimal fraction of one degree. Degrees and minutes divide a degree into 60 minutes. Convert $0^\circ 24'$ by calculating $24 \div 60 = 0.40^\circ$. Convert 0.25° to minutes by calculating $0.25 \times 60 = 15'$. A display of 0.24° is not $0^\circ 24'$. Distance-based toe additionally depends on a defined measuring diameter, so no single remembered distance-to-angle conversion works for every reference dimension.

Translate the picture into signed values

Toe describes wheel heading when viewed from above. Camber describes wheel tilt when viewed from the front. Caster describes steering-axis inclination in side view, not the tilt of the tire tread. Keep the view, reference direction and sign convention attached to the value. A diagram is a way to understand the quantity, not a substitute for vehicle specifications or the machine's procedure.

A total-toe calculation is signed addition. If left toe is $+0.12^\circ$ and right toe is -0.04° , total toe is $+0.08^\circ$. Adding magnitudes would incorrectly produce $+0.16^\circ$. Cross-angle calculations require a declared subtraction order: left minus right is the negative of right minus left. Angular minutes also differ from decimal hundredths: $0^\circ 24'$ equals $24/60 = 0.40^\circ$, not 0.24° .



Keep the viewing direction attached to the angle. Concept illustrations show negative camber from the front and toe-in from above. They are not adjustment instructions or target angles. Concept illustration; use the vehicle-specific procedure for service.

Try it before reading the answer

Calculate total toe from $+0.10^\circ$ and -0.06° . Then convert $0^\circ 12'$ to decimal degrees. Explain why those are different operations.

Worked answer and reasoning

Total toe is $+0.04^\circ$ by signed addition. Twelve angular minutes are $12/60 = 0.20^\circ$. The first combines two values already in the same unit; the second changes the representation of one angle. Neither operation uses tire pressure or an assumed universal linear-to-angular factor.

Interpret an alignment report before adjusting

Save the initial readings before changing anything. Compare each value with the correct range, including individual toe, total toe, camber, caster, and rear thrust angle as applicable. A green total can hide an individual value outside its limit. Likewise, matching left and right values does not mean either is within specification.

Fictional training report - not service specifications

Measurement	Before	Allowed range	Interpretation
Left front camber	-0.4°	-0.8° to +0.2°	Within range
Right front camber	-1.2°	-0.8° to +0.2°	Outside range
Left front toe	+0.20°	+0.02° to +0.12°	Outside range
Right front toe	-0.02°	+0.02° to +0.12°	Outside range
Total front toe	+0.18°	+0.04° to +0.24°	Within range, but not the whole result

For this exercise, a total-toe-only judgment would miss both individual toe errors. The camber problem needs investigation of setup, ride height, component condition, subframe position and adjustment provisions. It does not justify declaring one particular part bent without evidence.

Define any cross-angle calculation before using it. If cross-camber is defined as left minus right, $-0.4 - (-1.2) = +0.8^\circ$. Do not compare that signed result with a reference using the opposite convention. Cross-angle interpretation must account for the manufacturer's guidance and the complaint.

Decision exercise

List the out-of-range values, one setup condition to reconfirm, and one mechanical inspection to perform. Explain why adjusting the front toe to hide a rear thrust error is not a complete repair.

Read a report in layers

First confirm identity, units and setup. Then compare individual readings with their own ranges. Next consider axle totals and cross-angles using the stated conventions. Finally interpret the whole pattern with the complaint and mechanical findings. This order prevents a green total from distracting you from an out-of-range individual reading or an incorrect reference.

For a fictional axle, left toe is $+0.18^\circ$ and right toe -0.02° . Total toe is $+0.16^\circ$. If each individual limit is $+0.03^\circ$ to $+0.09^\circ$ and the total limit is $+0.06^\circ$ to $+0.18^\circ$, the total passes while both individuals fail. Moving the steering wheel to conceal an unequal split is not the same as establishing the required geometry and steering center under the procedure.

A camber result outside a nonadjustable range does not identify a bent strut by itself. Check whether the selection and setup are correct, whether ride height is correct and repeatable, and what component or

mounting evidence exists. Tire wear is historical evidence: correcting today's reading does not erase wear already present or prove which past condition produced it. Explain that distinction when the customer expects old tires to become unworn after adjustment.

Read the complete report, not just the total

The fictional training report below intentionally contains an acceptable total with unacceptable individual values. The total of $+0.20^\circ$ and -0.04° is $+0.16^\circ$, within the supplied total range. However, each wheel is outside its individual range. Calling that entire axle correct would hide the toe split and its implications for the steering reference. Reconcile individual and total requirements, then follow the specified adjustment procedure.

Similarly, left and right camber can match each other while both fail their absolute range. Symmetry does not establish compliance. When an angle is outside its reference, verify setup and investigate the mechanical cause before naming a failed part. Retain the initial readings and reference range so the customer and next technician can understand the decision.

Fictional alignment report-not vehicle specifications

Measurement	Reading	Supplied training range
Left individual toe	$+0.20^\circ$	$+0.02^\circ$ to $+0.10^\circ$
Right individual toe	-0.04°	$+0.02^\circ$ to $+0.10^\circ$
Total toe	$+0.16^\circ$	$+0.04^\circ$ to $+0.20^\circ$
Left / right camber	-0.3° / -0.9°	Evaluate individually

Try it before reading the answer

Which toe values fail? Calculate cross-camber using left minus right. What cannot be concluded from this report alone?

Worked answer and reasoning

Both individual toe readings fail while total toe passes. Cross-camber is $-0.3 - (-0.9) = +0.6^\circ$. The report alone does not identify the cause, prove a component failure or establish whether a customer pull is resolved. Interpretation still requires the correct setup, applicable limits and vehicle procedure.

Adjust, verify and explain limitations

Follow the vehicle and equipment sequence rather than a memorized universal order. Where rear geometry is adjustable it often establishes the reference for subsequent front work, but the actual procedure controls. Identify the correct adjusters, allowable range and any one-time-use fasteners. Do not loosen unrelated structural fasteners or modify mounting holes without an approved repair procedure.

Center and hold the steering wheel as specified. Make controlled changes, settle the suspension when required, and remeasure after tightening. A value observed with loose fasteners is not the final result. Verify that the wheel remains centered and that toe, camber, caster and thrust readings meet the applicable requirements. Complete required steering-angle sensor resets or calibration steps; a mechanical adjustment does not itself perform an electronic calibration.

Before a road check, confirm secure fasteners, removed tools, safe tires, and no unresolved safety concern. Use the prescribed safe route and operating conditions. Record steering center, pull, noise and warning status. A persistent pull with acceptable angles needs further diagnosis; do not promise that every alignment cures vibration or tire wear.

Customer handoff

“We corrected the adjustable toe and saved the before/after readings. Right camber remains outside the specified range. We have not identified the cause yet; the next authorized step is inspection of ride height and related components.” This separates completed work, remaining evidence and the next decision.

Keep the vehicle identity, specification source, measurements, adjustments, torque/procedure reference, calibration results and road-check notes together. A report with an unresolved red value must explain the limitation rather than be presented as a fully successful alignment.

Close the loop on the original concern

The final screen is one part of verification. Save results with the fasteners secured and the vehicle settled under the applicable method. Confirm the required electronic resets or calibrations separately; a steering-angle value on a scan screen is not proof that a required calibration completed. Retain any procedure result and fault information needed to support the handoff.

Compare the original complaint with the final safe functional check. If the wheel is centered but the pull remains, one concern may be improved while another remains unresolved. Say so. Consider remaining tire, brake, road, loading or mechanical evidence through an authorized diagnostic plan rather than repeatedly adjusting acceptable angles to chase a symptom. Do not use a public road test when a safety defect makes vehicle movement inappropriate.

Explain the printout

Point to the before value, applicable range and after value. Use plain language: “This is the direction the front wheel points; we corrected it into this vehicle's specified range.” State any uncorrected angle, why it remains and the next recommended action. The report should identify the vehicle, date, technician, source selection and limitations. A page with green bars but no valid identity or setup record is weak evidence of a completed service.

Verify geometry and the customer's concern

Final readings should represent the secured, settled vehicle, with required recalibration or reset steps completed. An angle can move as a fastener is tightened or the suspension is settled; saving the earlier value does not document the final state. Evaluate all affected readings after the specified sequence rather than checking only the angle initially adjusted.

A road check and a measurement report answer related but different questions. A persistent pull with in-range angles may require investigation of tires, brake drag, road conditions or other causes. Conversely, a centered steering wheel does not make an out-of-range measured value acceptable. Explain precisely what was verified, which condition remains and what next step is authorized.

Close the alignment record

- Secure Complete required fastener and settling steps
- Remeasure Save final readings against correct references
- Initialize Complete required vehicle-specific resets
- Verify Document concern check and remaining limitations

Try it before reading the answer

The screen is green before tightening, but one reading is outside its limit afterward. Which value belongs in the final report?

Worked answer and reasoning

Use the final secured and remeasured state. Correct the condition through the prescribed procedure and recheck affected angles before claiming completion. An earlier green screen is not evidence of the delivered vehicle's geometry.

Work the shop cases

Total toe masks an unequal split

A fictional report shows left toe $+0.17^\circ$, right toe -0.01° , left camber -0.3° and right camber -1.0° . Supplied limits are individual toe $+0.02^\circ$ to $+0.10^\circ$, total toe $+0.04^\circ$ to $+0.20^\circ$, and camber -0.7° to $+0.1^\circ$. Cross-camber is defined here as left minus right. The vehicle's right ride height is also below the supplied reference.

Calculate total toe and cross-camber. Mark each individual angle in or out. Decide whether a front-toe adjustment alone can honestly be sold as resolving the whole condition. List three questions that must be answered before recommending a component.

Your evidence, decision and next step:

Compare with the model answer

Total toe is $+0.16^\circ$, inside the supplied total range. Both individual toe readings are outside their ranges. Left camber is inside; right camber is outside. Cross-camber is $-0.3 - (-1.0) = +0.7^\circ$ using the specified convention. No cross-camber pass/fail limit was supplied, so do not invent one.

A toe adjustment does not explain or correct the low corner and out-of-range camber by itself. Confirm the vehicle/configuration and load selection, repeat the ride-height and alignment setup correctly, and inspect the relevant suspension and mounting conditions. Ask what is actually adjustable under the vehicle procedure. The component recommendation must follow evidence; the report does not uniquely identify a spring, strut, arm or subframe fault.

A green report with an unresolved pull

The customer reports a consistent pull. After an authorized adjustment, the saved angles meet the applicable limits and the steering wheel is centered. During a safe prescribed check the pull remains. A teammate proposes making one angle deliberately incorrect until the driver no longer notices the pull. The tire inspection notes were incomplete.

Write the appropriate job status, the next diagnostic questions and a customer update. Explain why a successful adjustment and a resolved complaint are different claims.

Your evidence, decision and next step:

Compare with the model answer

The adjustment may be complete, but the complaint is not verified resolved. Preserve the valid report and document the remaining symptom. Recheck tire condition and fitment, relevant pressure and load conditions, possible brake drag, road influence and mechanical findings under the proper diagnostic procedure. Obtain approval for additional work where required.

Do not intentionally move an angle outside its specification to mask an unidentified cause. Tell the customer: "The measured alignment angles are now within specification, but the pull is still present under the documented check. We recommend the next diagnostic step to identify the remaining cause." Avoid promising that another part or adjustment will solve it before evidence supports that conclusion.

Apply it to a job

Use the fictional report above. Calculate total toe and cross-camber (left minus right). Mark each individual value in or out of range. Write a setup checklist, a three-step investigation for the right camber, and a customer explanation. Then create a blank before/after table for a supervised job; leave specifications blank until you have the actual vehicle procedure.

Concern / scenario

Observation, measurement and reference

Interpretation and next action

Unknowns and who needs to review

Verification and handoff

Check your understanding

- Identify toe, camber and caster by view without relying on a label.
- Convert degrees/minutes and decimal degrees correctly.
- Check individual angles even when total toe passes.
- Separate repeatability, specification selection and mechanical condition.
- Explain an unresolved concern without manipulating the report or promising an unproved repair.

Practice assessment

Ungraded practice, separate from the final assessment. Answers and reasoning follow in the next section.

1. A target was mounted but compensation was skipped. Are the readings ready for a final adjustment decision?

- A. No; complete the equipment compensation procedure first.
- B. Yes if all values are green.
- C. Yes if the tires are new.
- D. Only total toe can be accepted.

2. In a training report, toe is $+0.07^\circ$ left and $+0.09^\circ$ right. What is total toe?

- A. $+0.02^\circ$
- B. $+0.16^\circ$
- C. -0.16°
- D. $+0.63^\circ$

3. Total toe is in range but both individual toe readings are outside their limits. Is the complete toe result acceptable?

- A. Yes; total always overrides individual values.
- B. Yes if camber is equal.
- C. No; individual values also need evaluation.
- D. Only the tire size decides.

4. After tightening an adjuster, the displayed angle changes outside specification. What follows?

- A. Save the earlier loose-fastener value.
- B. Reset the sensor to conceal the value.
- C. Deliver it because torque was completed.
- D. Remeasure and correct using the approved procedure.

5. Toe readings are $+0.10^\circ$ and -0.06° . What is their total?

- A. $+0.04^\circ$
- B. $+0.16^\circ$
- C. -0.04°
- D. -0.16°

6. What is $0^\circ 12'$ in decimal degrees?

- A. 0.12°
- B. 0.20°
- C. 1.2°
- D. 0.02°

7. Both camber values are -1.0° ; the supplied range is -0.7° to $+0.1^\circ$. What is true?

- A. Both pass because they match
- B. Only the side with more toe fails
- C. Both fail despite matching
- D. Their average passes

8. A pull remains after in-range final readings. What should the handoff say?

- A. The pull is resolved because geometry passes
- B. The alignment proves a tire defect
- C. The alignment proves brake drag
- D. Geometry readings meet their reference; the pull remains under investigation

Answer explanations

1. No; complete the equipment compensation procedure first.

Compensation addresses mounting/runout effects. Green values, new tires or selecting just one angle do not establish a valid setup.

Review: Prepare a vehicle that can be measured accurately

2. +0.16°

Add the signed angles: $0.07 + 0.09 = 0.16$. Subtracting finds a difference, not total toe; multiplication is not used.

Review: Read the angles and their units

3. No; individual values also need evaluation.

A correct sum can hide an unequal split. Camber and tire size do not erase individual toe requirements.

Review: Interpret an alignment report before adjusting

4. Remeasure and correct using the approved procedure.

The final condition is the tightened, settled vehicle. Earlier values and sensor resets cannot substitute for final geometry.

Review: Adjust, verify and explain limitations

5. +0.04°

Add signed values, not magnitudes.

Review: Read the angles and their units

6. 0.20°

12 divided by 60 is 0.20.

Review: Read the angles and their units

7. Both fail despite matching

Equal values may both be outside an absolute range.

Review: Interpret an alignment report before adjusting

8. Geometry readings meet their reference; the pull remains under investigation

A measurement pass is not proof of symptom resolution or a unique alternative cause.

Review: Adjust, verify and explain limitations

Further study

Use current vehicle and equipment information for actual service. These resources support further learning; lessons and questions in this book are original.

ASE public automobile task lists and sample formats

https://www.ase.com/wp-content/uploads/ASE_Automobile_Study_Guide.pdf

Hunter equipment operation resources

<https://www.hunter.com/en-ca/support/equipment-digital-resources/>

Alignment equipment operation - Hunter

<https://www.hunter.com/globalassets/hunter/products/alignment-systems/winalign-standard/documents/align-winalign-ops-3850-t.pdf>