

## Wheel Alignment Terminology

Wheel Toe

Toe-Out-On Turns

Camber Angle

King Pin Inclination (KPI) & Included Angle

Castor Angle

Lock Angles

Rear Wheel Steering

Axis of Symmetry & Thrust Axis Deviation

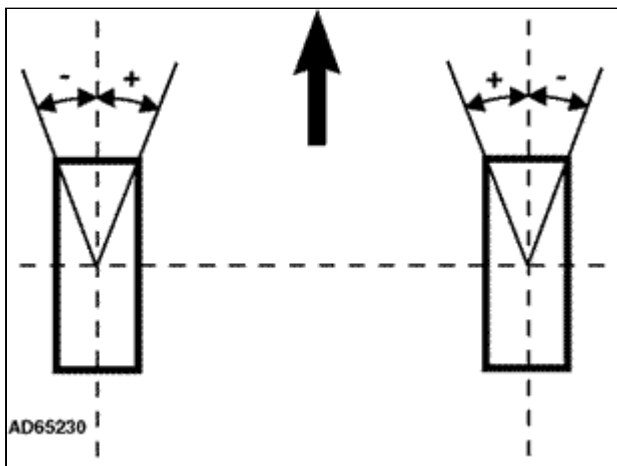
Wheel Set-Back

Ride Height

Tyres

Adjustment Procedures

### Wheel Toe

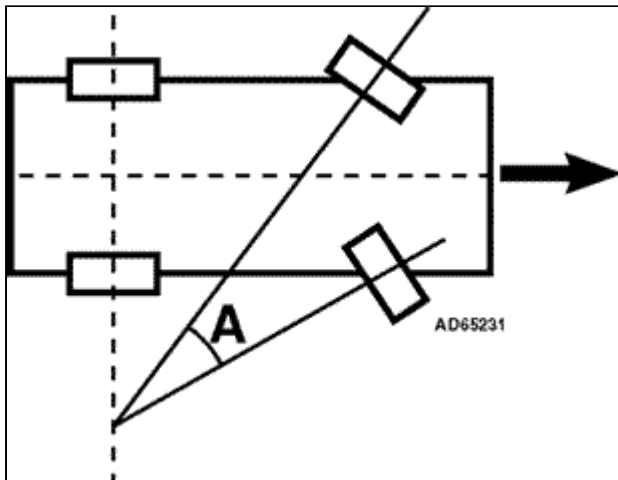


**+ = toe-in**  
**- = toe out**

The toe setting is the amount by which the front or rear wheels point inwards or outwards at the front of the wheel in relation to each other. When the wheels point inwards they are said to toe-in. Toe-in figures are given a positive value. Conversely when the wheels point outwards they are said to toe-out and the figures are shown as a negative value.

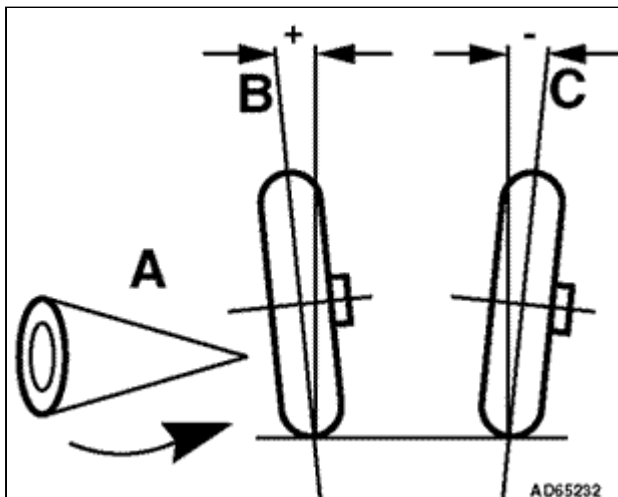
The purpose of correct toe is to ensure that the wheels run parallel when the vehicle is in motion. An incorrect toe setting may affect the stability and controllability of the vehicle.

### Toe-Out-On Turns



Toe-out-on-turns is the difference in angles between each front wheel and the centre line of the vehicle when the steering is turned. The steering linkage is designed to allow the inner wheel to turn through a smaller radius to minimise tyre scrub. There should be no difference in angle (A) when the steering is turned to the left or right, taking into consideration manufacturer's tolerances.

### Camber Angle

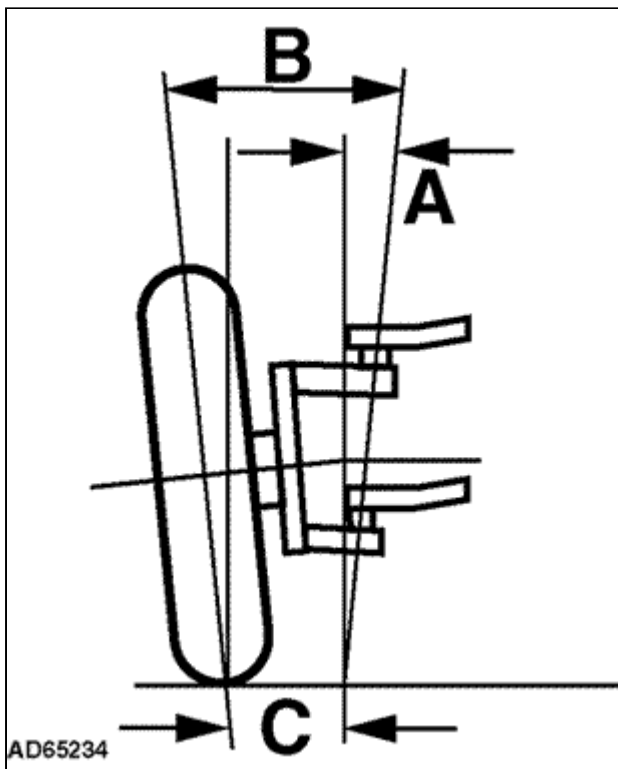


If the road wheel leans outwards from the vertical, it is said to have positive camber (B) and when leaning inwards from the vertical negative camber (C), looking from the front or rear of the vehicle.

The effect of camber can be compared with the tendency of a cone to roll towards its small end (A). Therefore, wheels which are both set at a positive camber angle have the tendency to roll away from each other while wheels set at a negative camber angle will roll towards each other.

Camber angle is measured in degrees with the wheels in the straight-ahead position.

### King Pin Inclination (KPI) & Included Angle



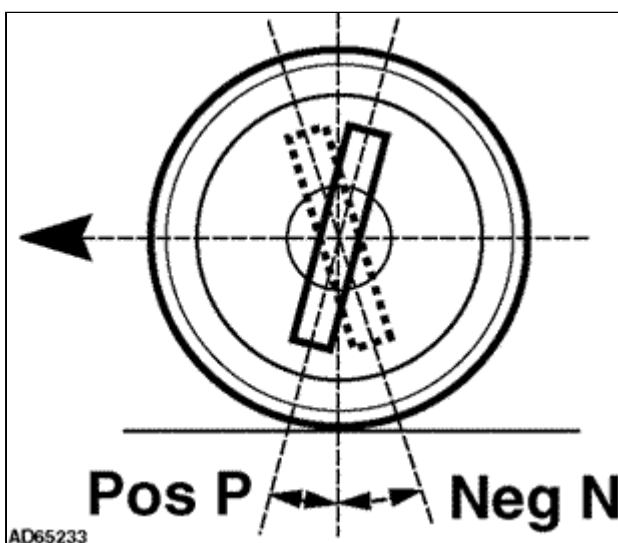
KPI is the angle of inclination of the king pin towards the centre line of the vehicle from the vertical (A).

On systems which use swivel joints the king pin is effectively the line drawn through the steering axis of the joints, hence the term Steering Axis Inclination (SAI).

The Included Angle is the camber angle plus the king pin angle (B). Lines drawn through the camber angle and the king pin angle will intersect. If the lines intersect below the road surface, the dimension is described as positive scrub radius (C). If the two lines intersect above the road surface the dimension is called negative scrub radius.

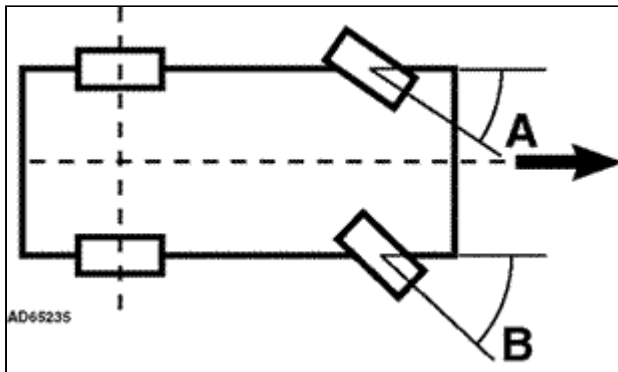
A small scrub radius will contribute to steering stability. On vehicles with diagonally split brake circuits negative scrub radius stabilises the steering when the braking forces of the front wheels are unequal.

### Castor Angle



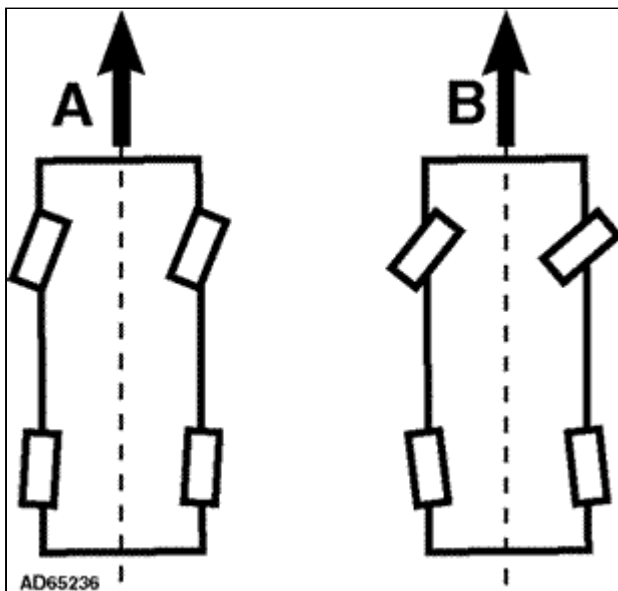
The castor angle is the tilting of the kingpin either forwards or backwards from the vertical, as seen from the side of the vehicle. Castor angle influences the directional stability of the steering. To increase the tendency of the steering to self-centre, the steering will normally be designed with positive castor.

### Lock Angles



This is the angle of the inner or outer wheels on left and right-hand lock, relative to the straight-ahead position. It will be seen that the inner wheel (B) will turn through a greater angle than the outer wheel (A) to reduce tyre wear.

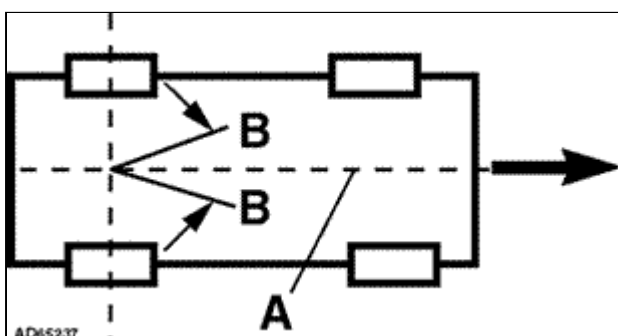
### Rear Wheel Steering



A number of vehicle manufacturers have introduced rear wheel steering systems with various means of operation. A basic system is designed to turn the rear wheels in the same direction as the front wheels over speeds of approximately 20-30 mph (A). A more sophisticated system will turn the wheels in the opposite direction to the front wheels at low speed (B), reverting to the same direction of turn as the front wheels when the speed increases. Increased stability, higher cornering speeds and improved manoeuvrability are amongst some of the claimed advantages of rear wheel steering.

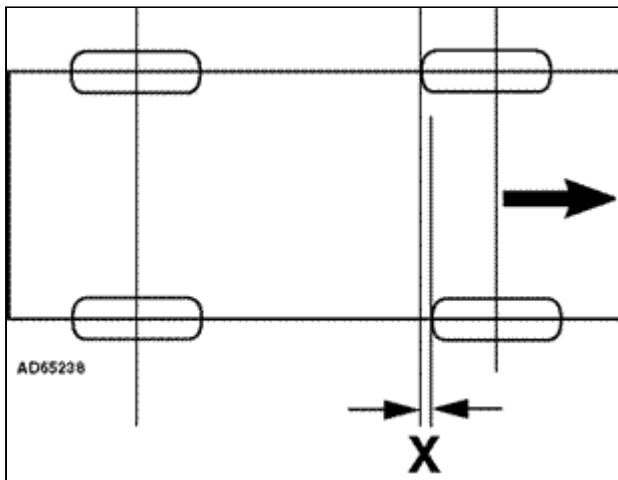
It is essential to consult the vehicle manufacturer's manual before attempting to adjust the rear wheel steering alignment.

### Axis of Symmetry & Thrust Axis Deviation



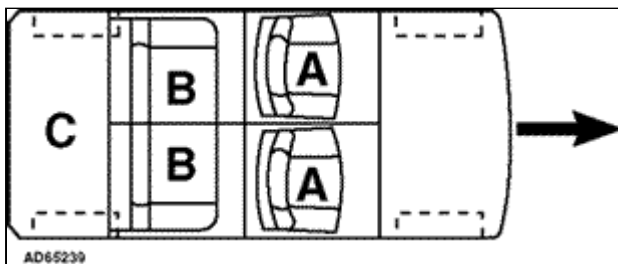
The axis of symmetry is the centre line through the front and rear axles (A). Incorrect toe-setting of the rear wheels or wheel set-back may cause the vehicle to travel in a direction different from the centre line. This is known as the thrust axis deviation (B).

### Wheel Set-Back



This is the distance (X) by which one wheel is offset to the front or rear, relative to the opposite wheel on the same axle. Wheel set-back can also be measured as an angle.

### Ride Height



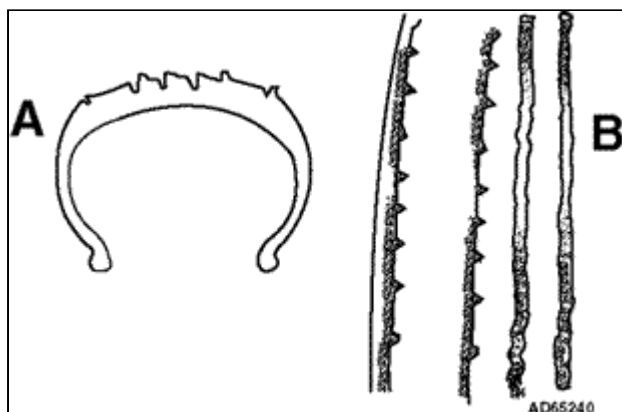
### Test Load Positioning

If a manufacturer's geometry figures are determined with a specified load applied to the suspension, the position of the load on the vehicle will be indicated. The load may have to be positioned on the front seats (A), rear seats (B), or luggage compartment (C), or a combination of the three, depending on the manufacturer and model.

### Suspension Settling

The suspension of vehicles is liable to settle initially with use. To make allowance for settling of the suspension, manufacturers may provide a table of geometry settings to be used in conjunction with suspension height measurements. Where applicable, these values and their respective measuring points will be shown.

### Tyres



### Tyre Wear

Incorrect wheel alignment will cause abnormal tyre wear. The illustration in Fig. 11 shows the effect that excessive toe-in or toe-out will have on tyre treads. Excessive toe-out will cause feathering (A) and wear (B) on the inside shoulder of the tyre while excessive toe-in will cause wear and feathering on the outside shoulder of the tyre.

### Tyre Pressures

The pressure of the four vehicle tyres should be examined and corrected prior to checking and adjusting the wheel alignment.

### Tyre Markings

Before carrying out wheel alignment checks, ensure that all road wheels are fitted with the correct size tyres and that tyres on the same axle are of equal size.

## Adjustment Procedures

### Preparatory Conditions

The following items should be checked before measuring the wheel alignment:

1. Correct tyre sizes and pressures.
2. Condition of road springs/suspension (Vehicle visibly level).
3. No excessive free play in steering mechanism and linkage.
4. Wheel bearings correctly adjusted.
5. No excessive run-out in road wheels (buckled wheels must be replaced).
6. Test loads positioned in vehicle (if specified).
7. Vehicle has been bounced on suspension with handbrake OFF.
8. Steering centralised by marking the steering wheel and then turning the steering wheel from lock to lock measuring the turns. With the steering centralised, the front wheels should be approximately parallel with the longitudinal centre line of the vehicle. Some vehicles with rack and pinion steering specify the length of one or both track rods as a guide when centralising the steering, others feature an access hole in the housing through which a pin or screw has to be inserted in order to centralise the steering. Vehicles fitted with a steering box may have specific alignment points on the box.

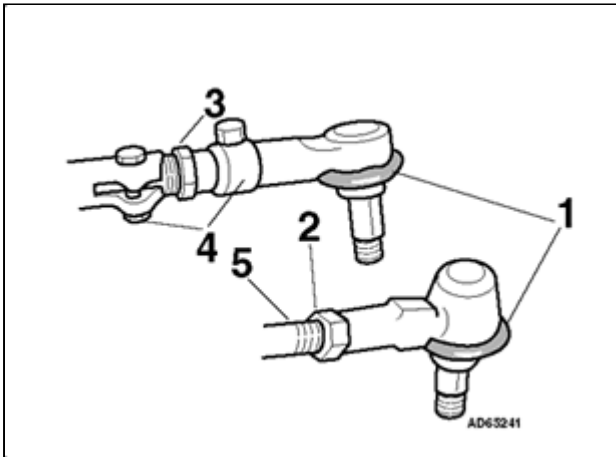
### Types of Adjustment

1. Wheel toe - typically, adjustment of the toe-setting can be made by slackening each track rod lock nut or clamp (Fig. 12) and turning the track rod or adjuster an equal amount on each side of the vehicle to lengthen or shorten the track rods as necessary.
2. Castor angle - adjustment may be achieved by lengthening or shortening the tie rod (Fig. 13). Alternatively, with wishbone type front suspension, shims between the wishbone mounting and chassis (Fig. 14) may be varied in thickness to alter castor settings.
3. Camber - the most common types of camber adjustment are:

- a. Altering the position of the top of the MacPherson strut.
- b. Varying the thickness of shims between wishbone mounting and chassis (Fig. 14).
- c. Altering the position of the ball-joint on the wishbone (A, Fig. 15).
- d. Cam adjustment at the bottom of the strut (B, Fig. 15).

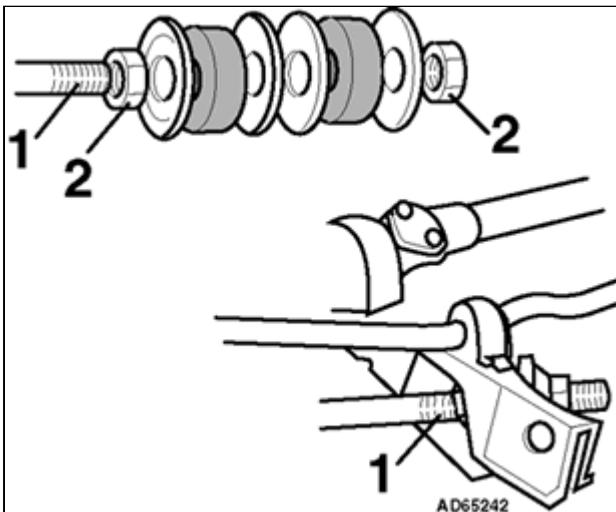
All the above adjustments may also apply to rear suspensions.

Fig. 12



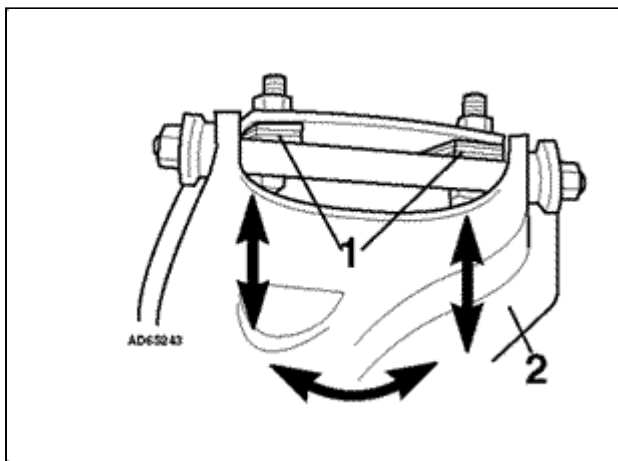
1. Track rod end
2. Locknut
3. Adjuster
4. Clamp
5. Track rod

Fig. 13



1. Tie rod
2. Locknut

Fig. 14



- 1. Shims
- 2. Wishbone

Fig. 15

