

AUTOMOBILE ENGINEERING

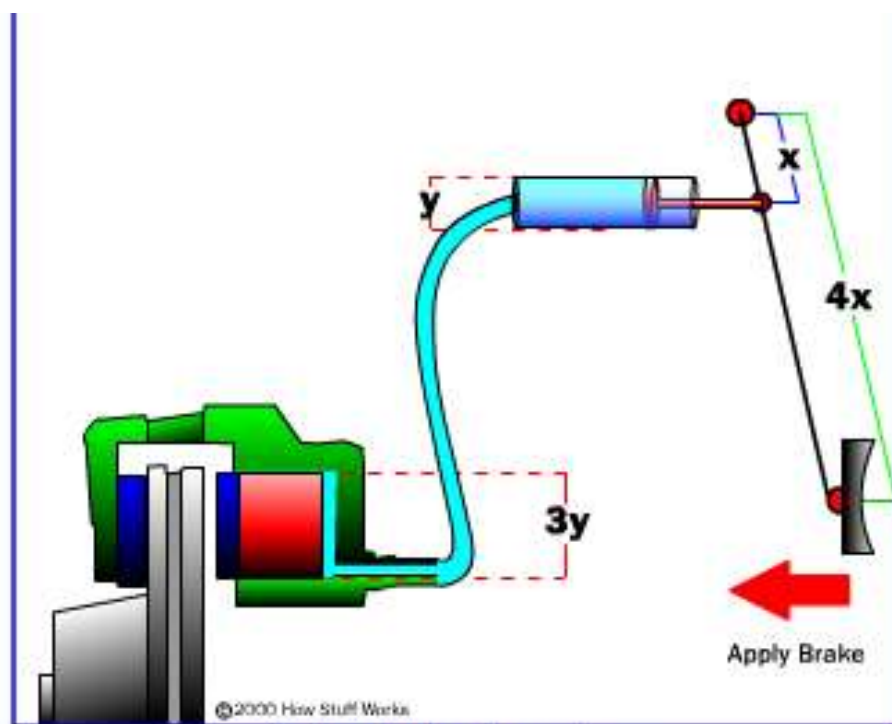
Bachelor of Engineering (Automobile engineering)

INTRODUCTION TO AUTOMOBILE

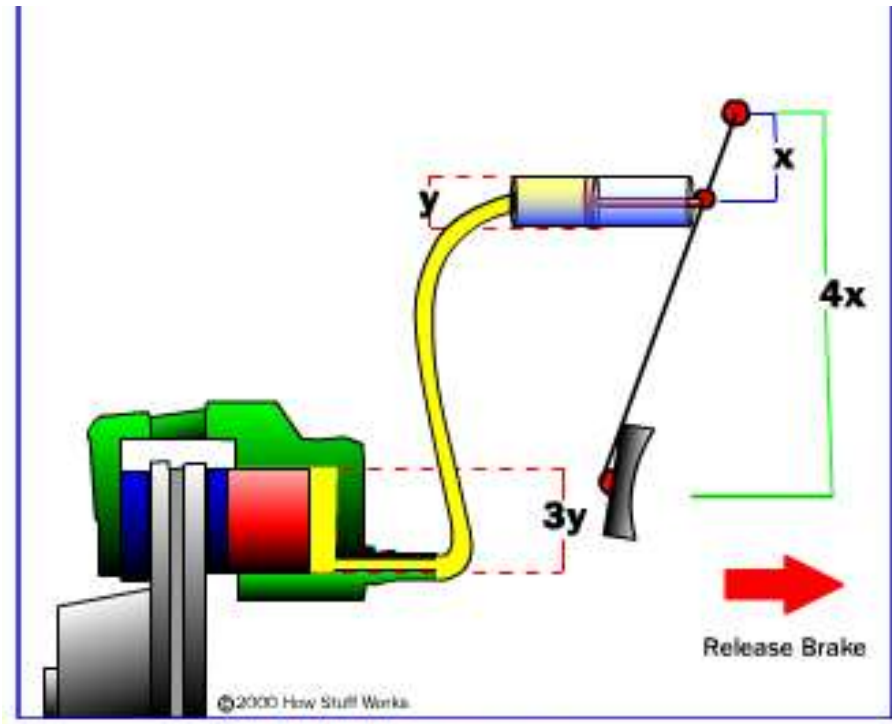
FSAE Braking Rules

- The car must be equipped with a braking system that acts on all four wheels and is operated by a single control.
- It must have two independent hydraulic circuits such that in the case of a leak or failure at any point in the system, effective braking power is maintained on at least two wheels.
- Each hydraulic circuit must have its own fluid reserve, either by the use of separate reservoirs or by the use of a dammed, OEMstyle reservoir.
- The brake system must be capable of locking all four (4) wheels during braking test.
- “Brake-by-wire” systems are prohibited.

Overall System



A simple brake system



A simple brake system

Master Cylinder

- Wilwood TM1 Tandem MC
- 5/8" Bore
- 1.31" Stroke
- Compact Design
- Lightweight
- Mounting Bracket

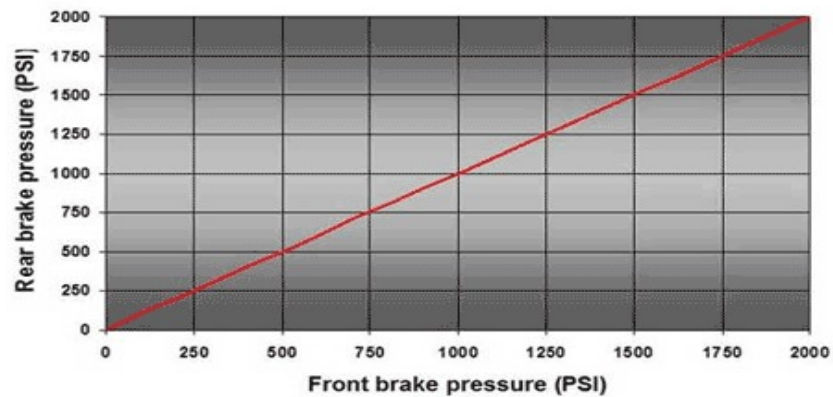


TM1 Tandem Master Cylinder

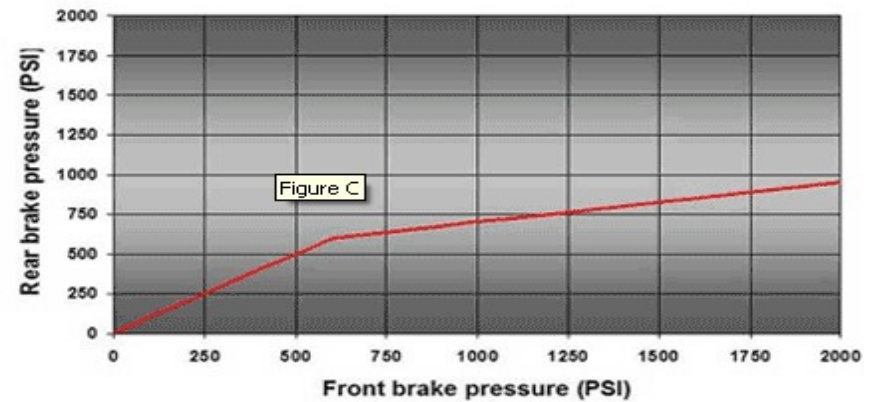
Proportioning Valve



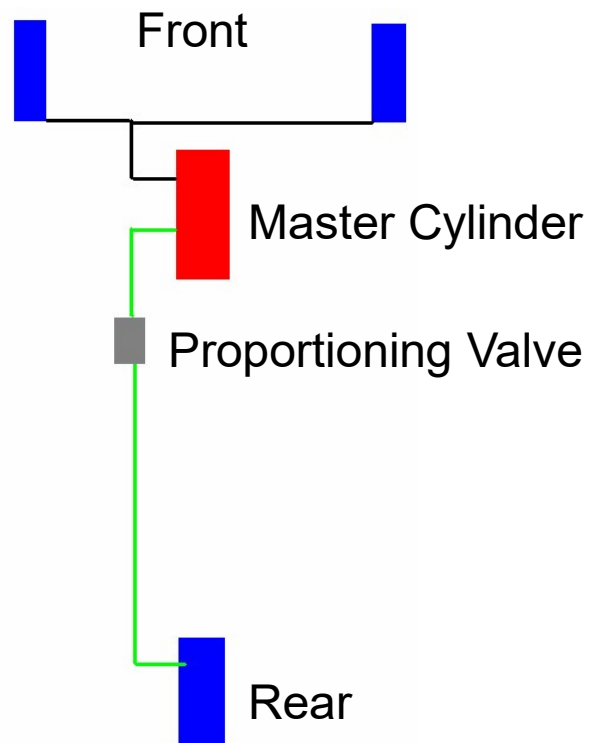
Brake Line Pressure Figure A
No front-to-rear regulation



Brake Line Pressure Figure C
With typical "proportioning valve"



Brake Lines



$$P_{cal} = P_{mc}$$

- where P_{cal} = the hydraulic pressure transmitted to the caliper

Calipers



- Wilwood PS1 Caliper
- 2 Pistons
- Piston Area: 0.79 in²
- Weight: 0.93 lbs

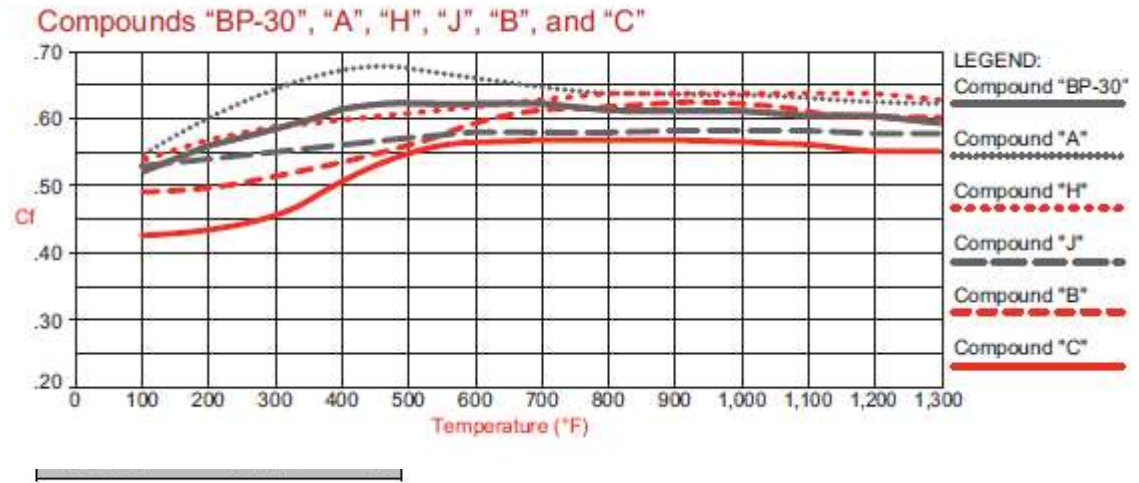
$$F_{cal} = P_{cal} \times A_{cal}$$

- where F_{cal} = the one-sided linear mechanical force generated by the caliper
- where A_{cal} = the effective area of the caliper hydraulic piston(s) found on one half of the caliper body

$$F_{clamp} = F_{cal} \times 2$$

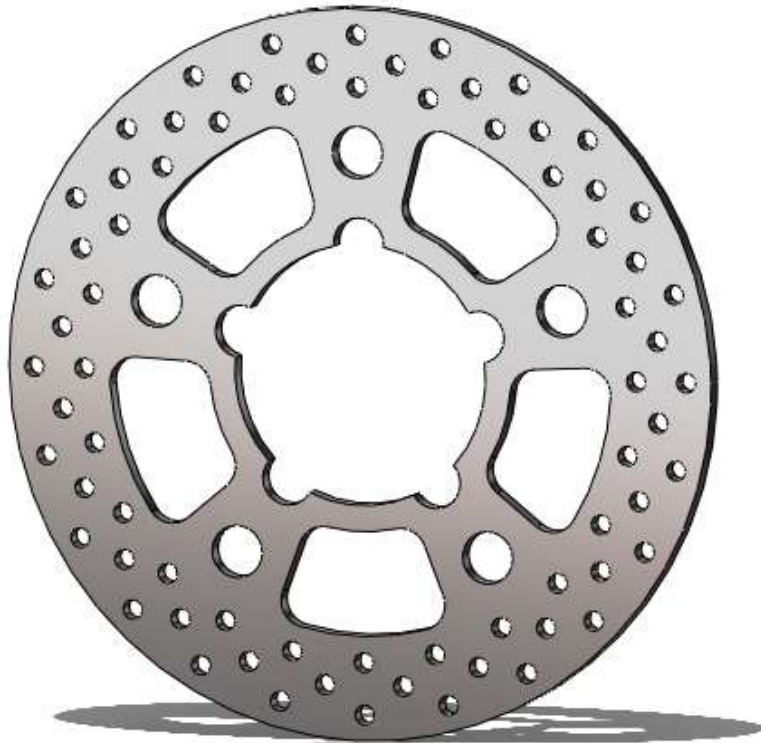
- where F_{clamp} = the clamp force generated by the caliper

Brake Pads



- where $F_{friction}$ = the frictional force generated by the brake pads opposing the rotation of the rotor
- where μ_{bp} = the coefficient of friction between the brake pad and the rotor

Rotor

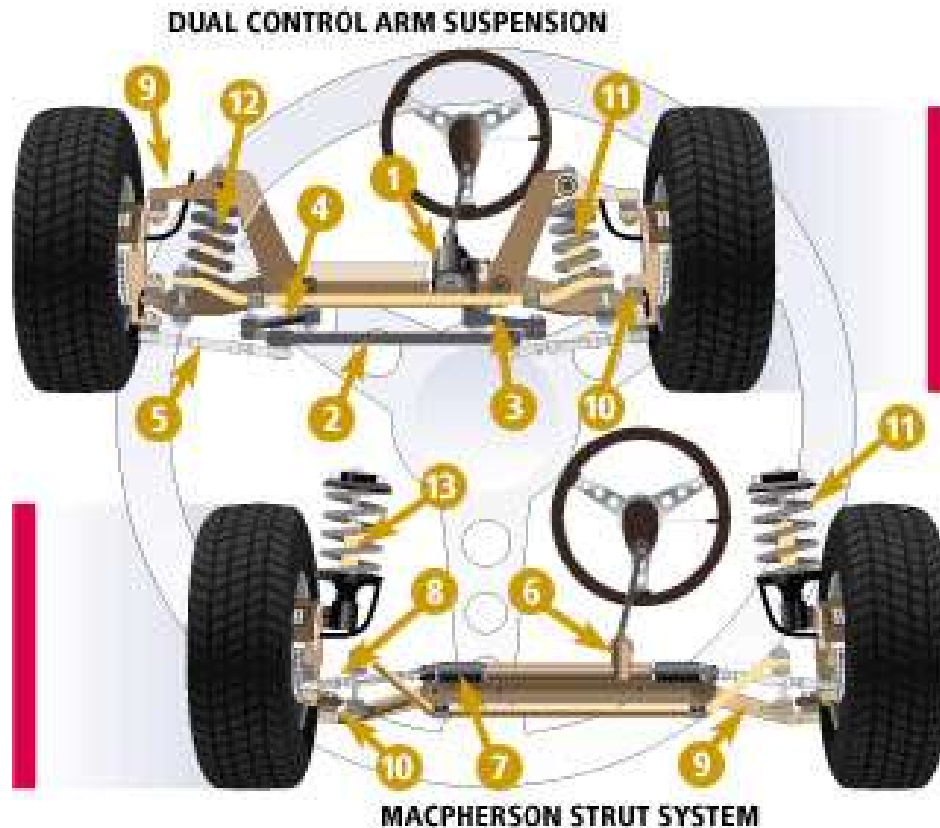


- Material: 420 Stainless Steel
- Dimensions: 7" OD 3/16" thick
- Mass: 1.22 lbs
- Floating Design



Suspension Systems

Suspension System



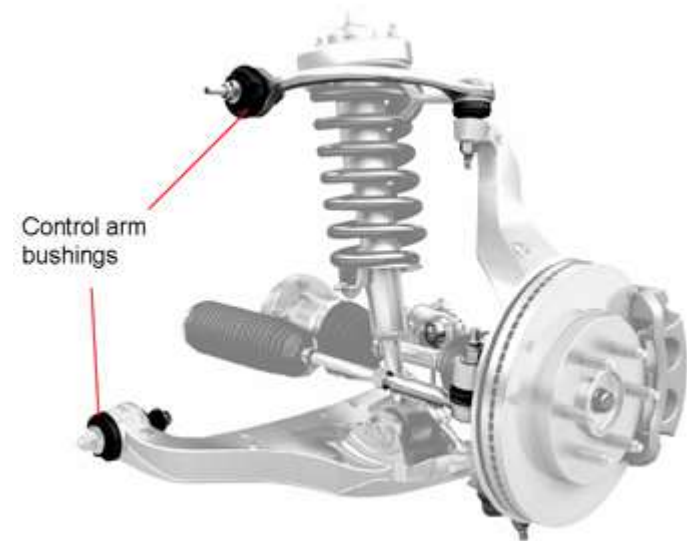
- Supports the weight.
- Provides a smooth ride.
- Allows rapid cornering without extreme body roll.
- Keeps tires in firm contact with the road.
- Prevents excessive **body squat**.

- Prevents excessive **body dive**.
- Allows front wheels to turn side-to-side for steering.
- Works with the steering system to keep the wheels in correct alignment.

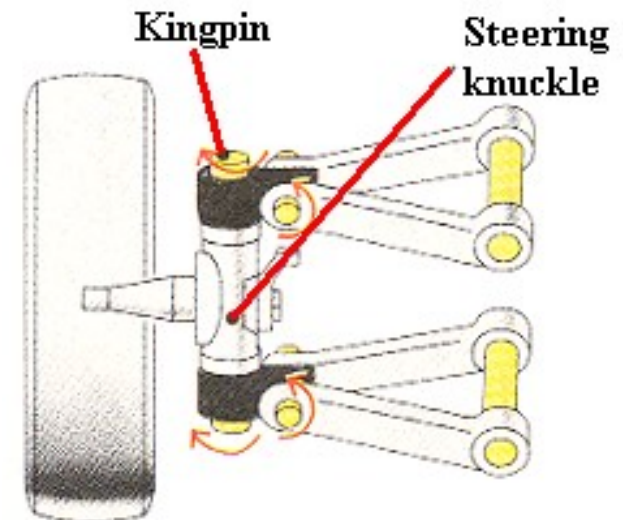
Suspension System

Basic Parts

Control arm – movable lever that fastens the steering knuckle to the vehicle's body or frame.



Steering Knuckle – provides a spindle or bearing support for the wheel hub, bearings and wheel assembly.



Suspension System

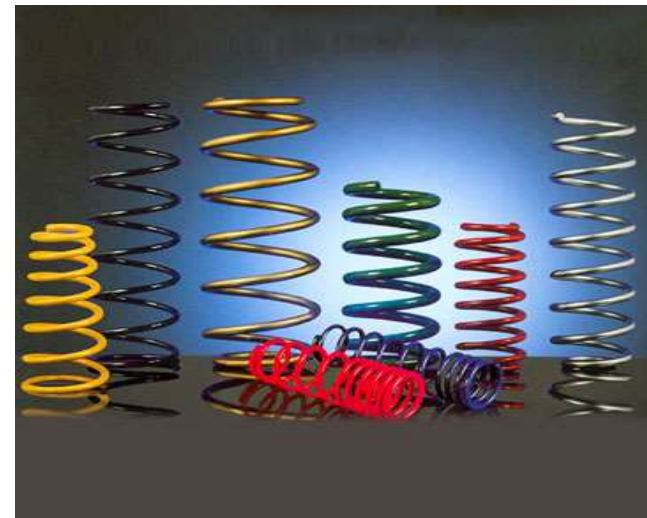
Basic Parts

Ball Joints – swivel joints that allow control arm and steering knuckle to move up and down and side to side.



Today's complex import suspension systems aren't tolerant of excessive wear.

Springs – supports the weight of the vehicle; permits the control arm and Wheel to move up and down.



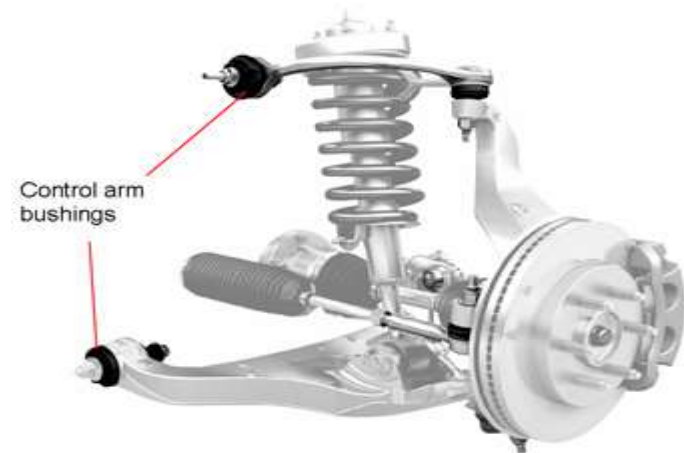
Suspension System

Basic Parts

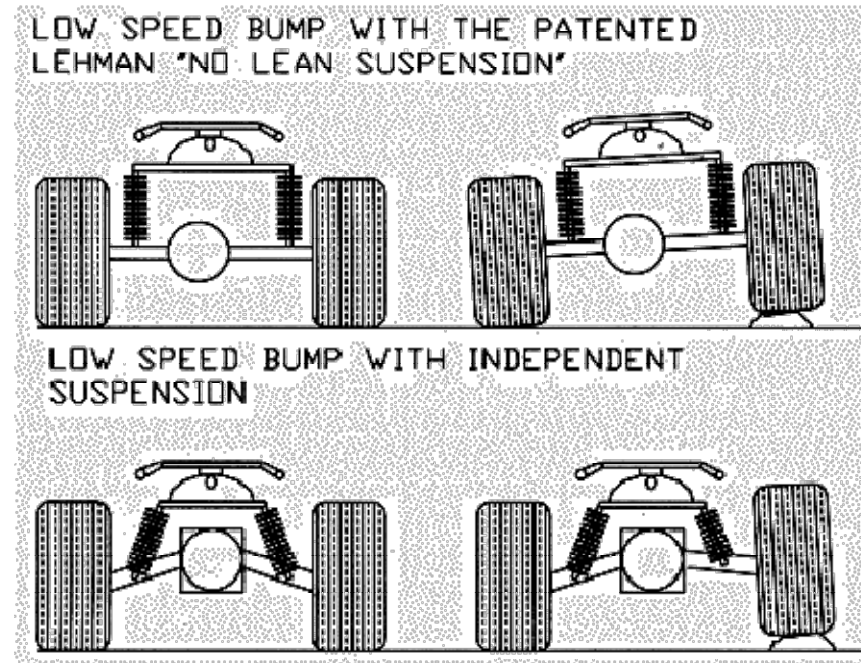
Shock absorbers or dampeners – keeps the suspension from continuing to bounce after spring compression and extension.



Control arm bushing – sleeves that allows the control arm to swing up and down on the frame.



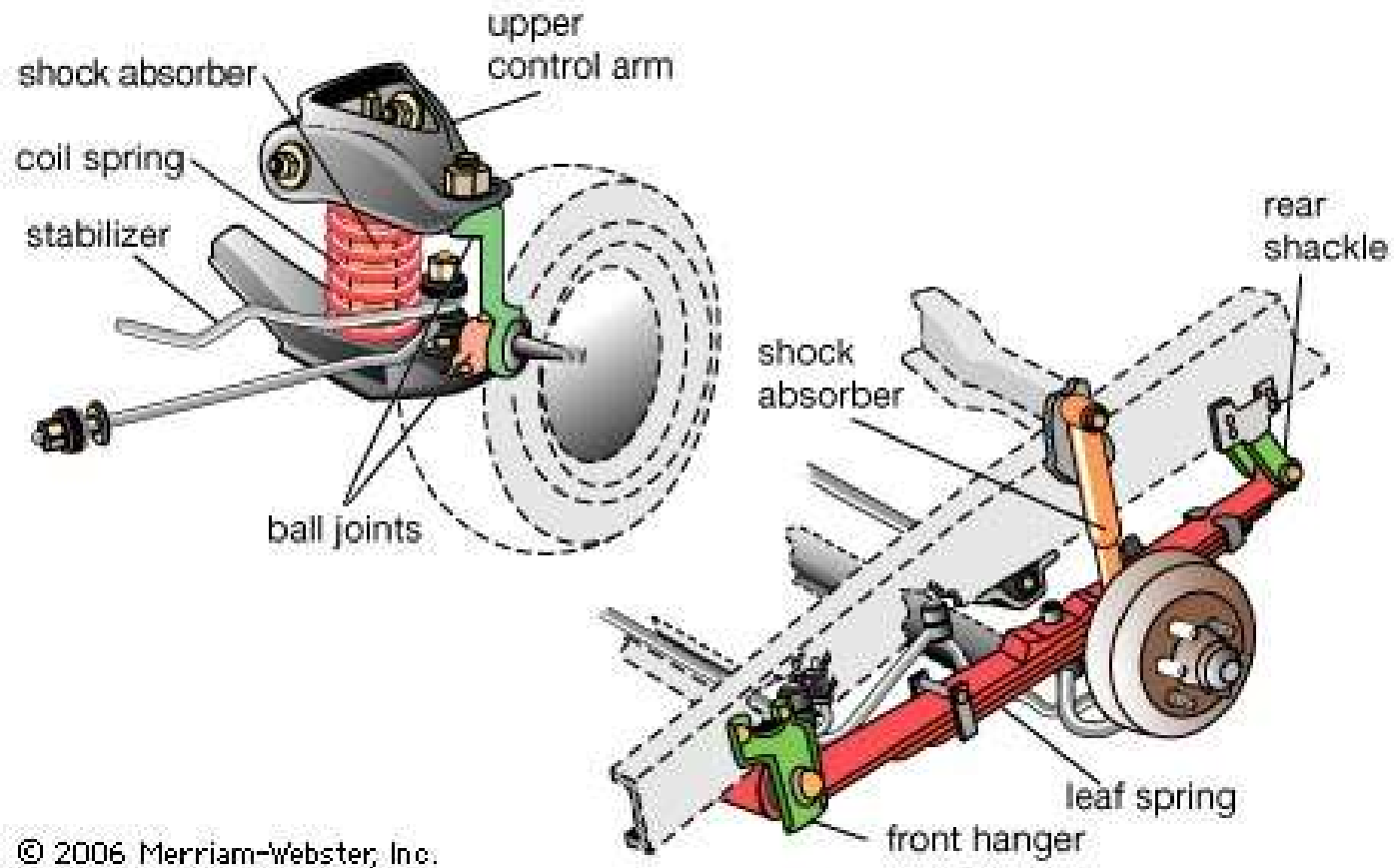
Suspension System



Non-independent suspension has both right and left wheel attached to the same solid axle. When one wheel hits a bump in the road, its upward movement causes a slight tilt of the other wheel.

Independent suspension allows one wheel to move up and down with minimal effect to the other.

Suspension System



Coil spring is the most common type of spring found on modern vehicles.

Leaf springs are now limited to the rear of some cars.

Suspension System

Torsion bar (*large spring rod*)



- One end is attached to the frame and the other to the lower control arm.
- Up and down of the suspension system twists the torsion bar.
- It will then try to return to its original shape, moving the control arm to its original place.

Suspension System

Sway Bar (*Stabilizer Bar*)



- Used to keep the body from leaning excessively in sharp turns.
- Fastened to lower control arms. (*rubber bushings are used*)
- During cornering, centrifugal force makes the outside of body drop and inside raise.
- The bar's resistance to twisting motion limits body lean in corners.

Suspension System

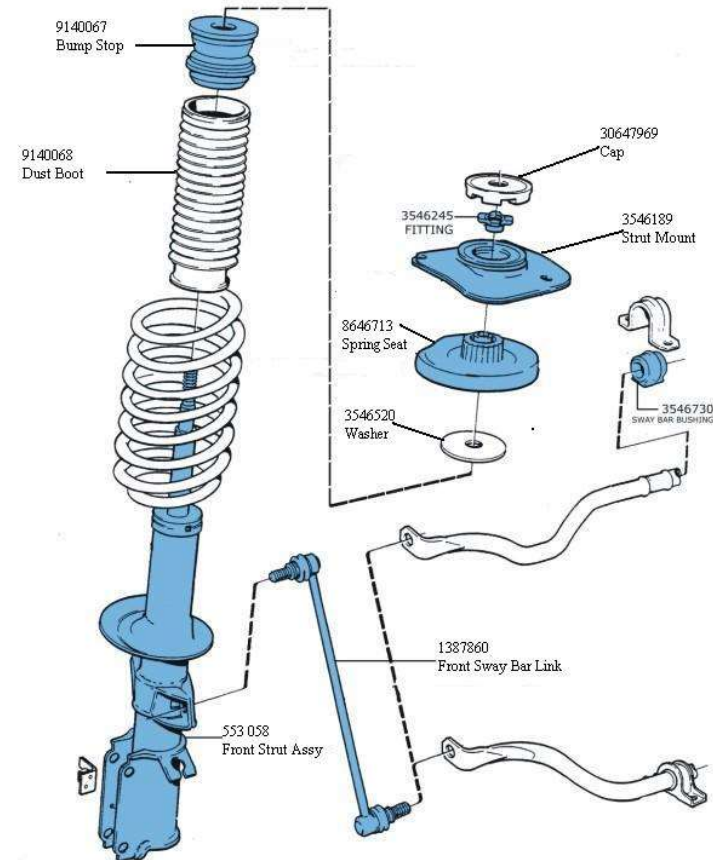
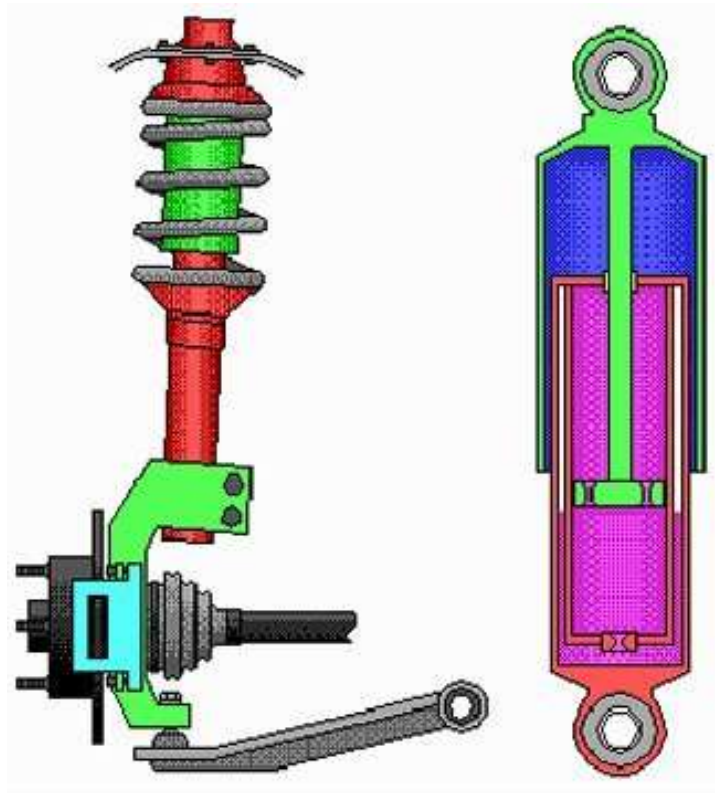
Shock absorbers

- Limits spring compression-extension movements to smooth the vehicle's ride.
- Without shock absorbers, the vehicle would continue to bounce up and down long after striking dip or hump in the road.



Suspension System

Strut assembly (*MacPherson struts*)

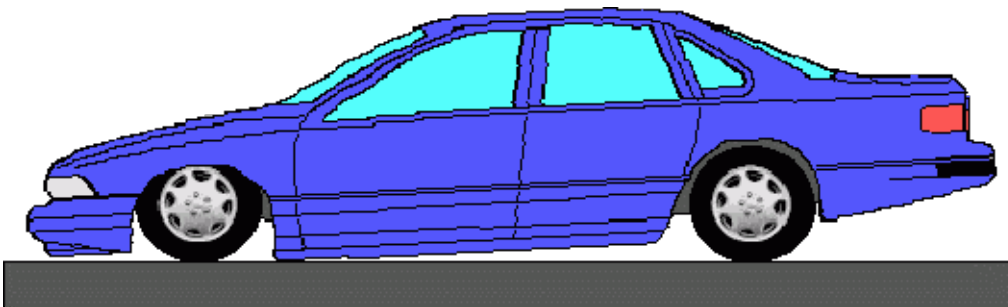


- Consists of a shock absorber, a coil spring, and an upper damper unit.
- Strut assembly often replaces the upper control arm.

Suspension System

Checking Shock Absorber Condition **Bounce test**

- Push down on one corner of vehicle's body.
- Release the body and count the number of times the vehicle rebounds.
- **Good – no more than two rebounds.**



Leaking Shocks

- Check for signs of leakage.
- If oily and wet, replace it.

Suspension System

Replacing Coil Springs

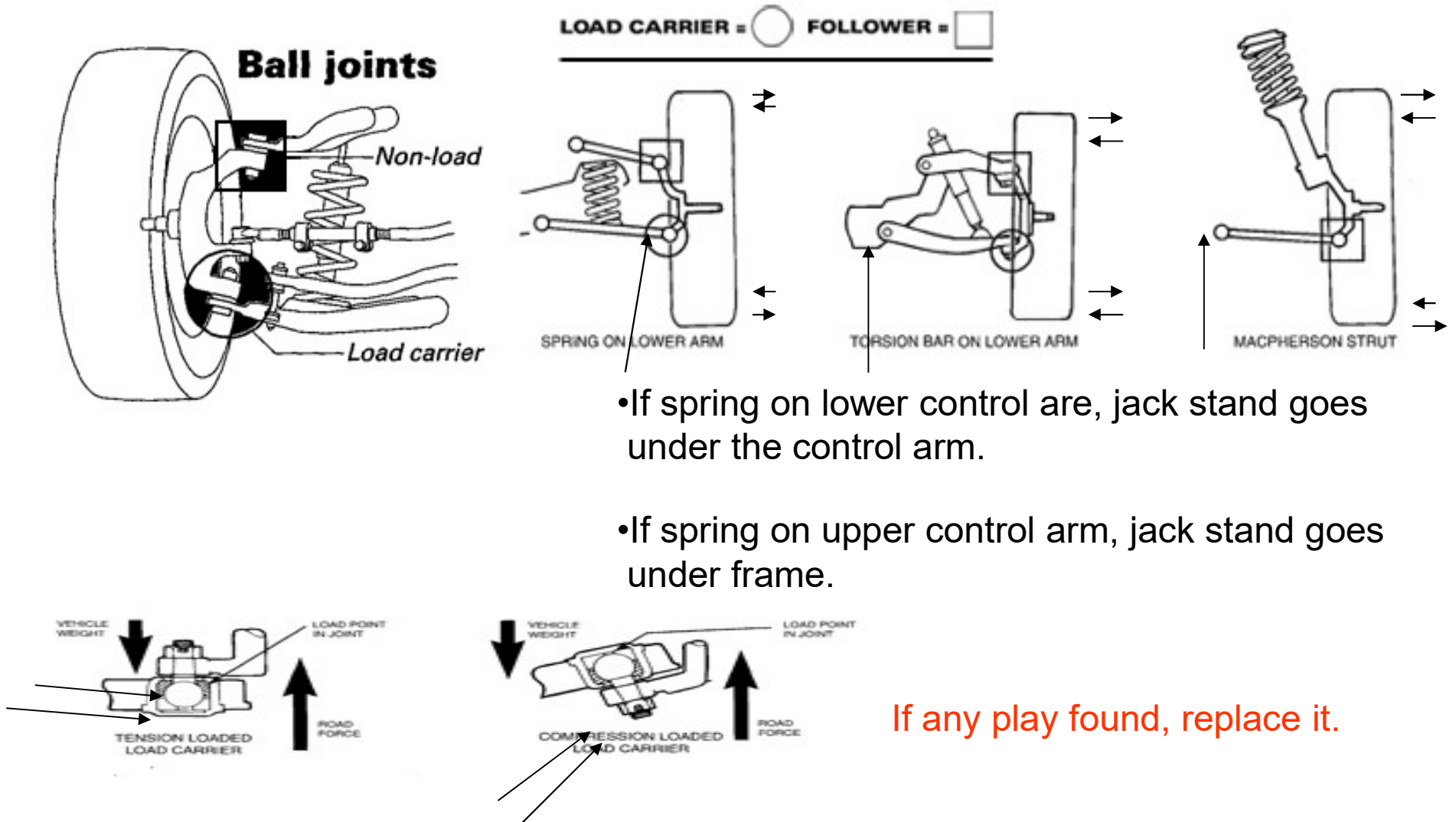


Need to compress the coil spring, before removing it.

Warning – A compressed coil spring has a tremendous amount of stored energy.

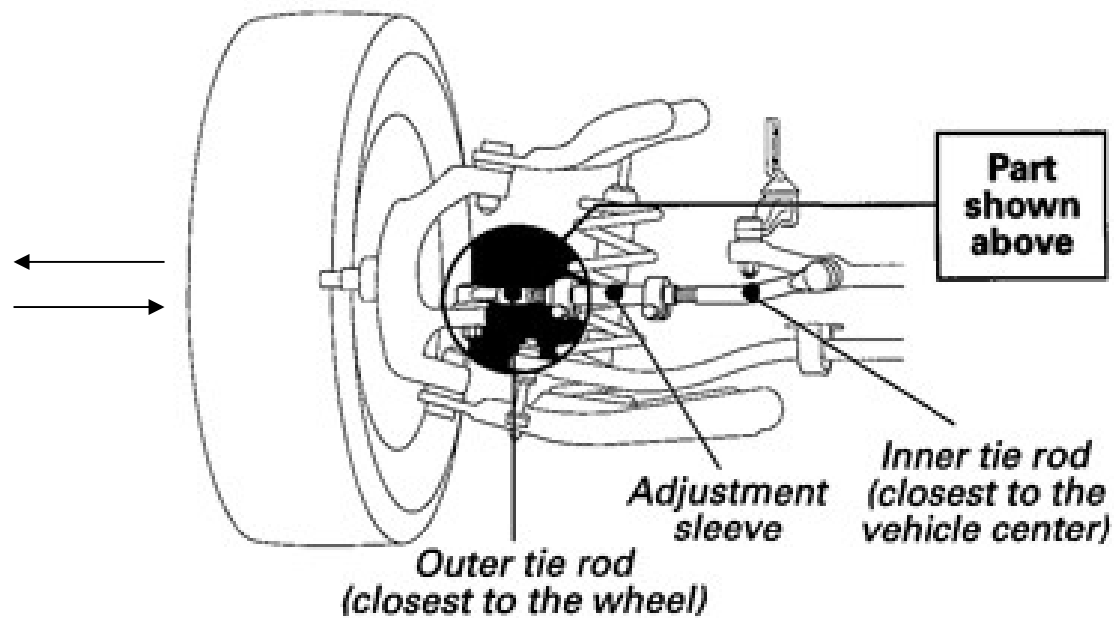
Suspension System

Checking Ball Joints



Suspension System

Tie Rod Inspection



Move the wheel side-to-side, should be no play.

Suspension System

Always grease all the grease points.



FAQ

1. What do you understand from mechanical brakes?
2. How brakes are adjusted mechanical?
3. What is the difference between open and closed coil springs?
4. List Various parts of Shock absorber.

Reference

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