GSA BASIC BRAKE SYSTEM TRAINING

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Functions of the brake system

- Reduce speed to stop vehicle
- Keep vehicle from moving when at stop

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HOW ?

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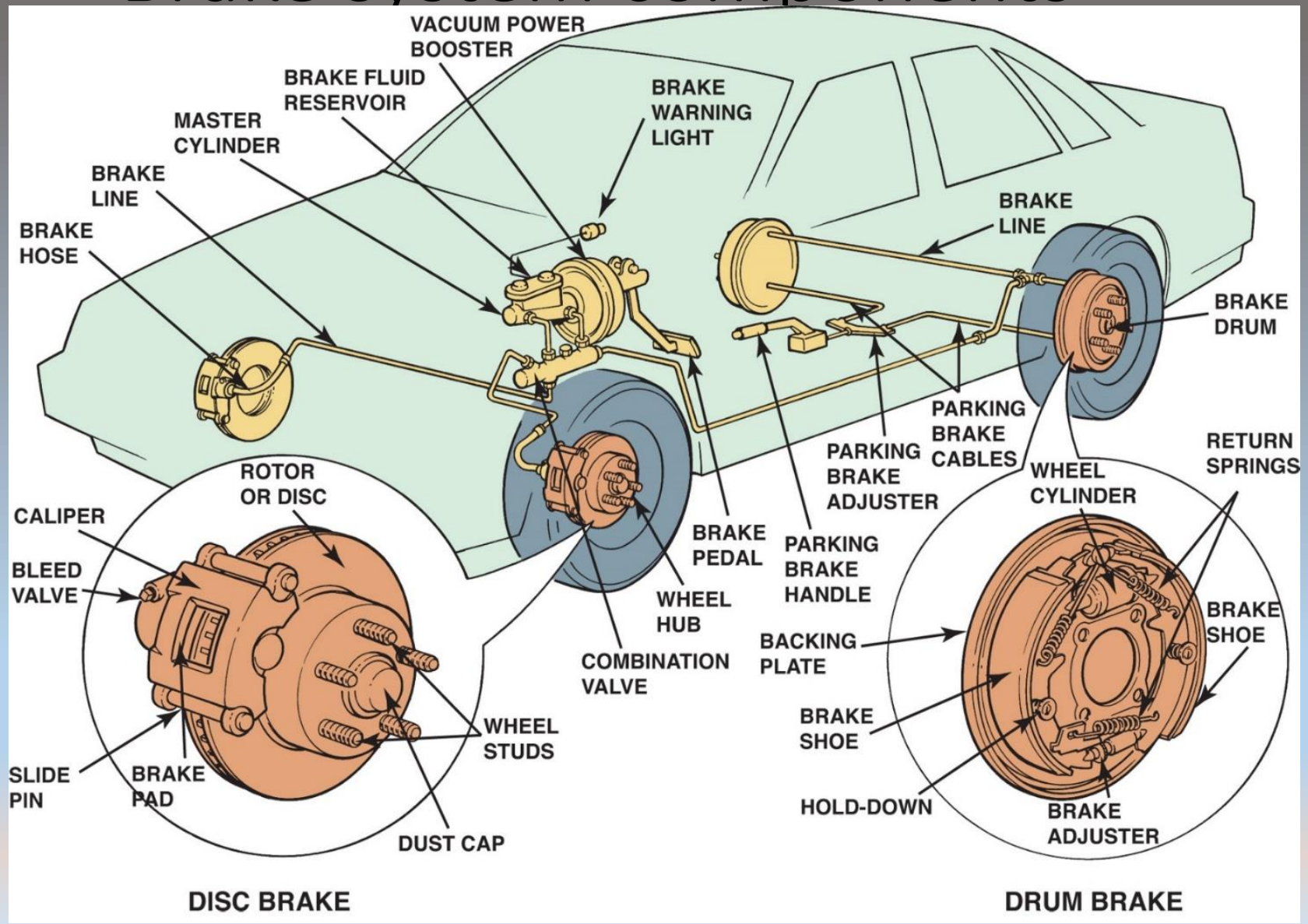
Converts vehicle movement into heat from friction when braking

BY THE USE OF STATIONARY BRAKE PIECE APPLYING FORCE TO A ROTATING PIECE

THE BIG QUESTIONS

- How to get from pushing a pedal to stopping car
  What kind of linkages involved
- How to get power brakes assistance
- What is involved in a “Brake Job”
- Any others

Brake system components



Categories of brake system

- Apply system
- Boost system
- Hydraulic system
- Wheel brakes
- Brake balance control system
- Brake warning lights
- Parking brake

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**majority of service needs in these 3 areas

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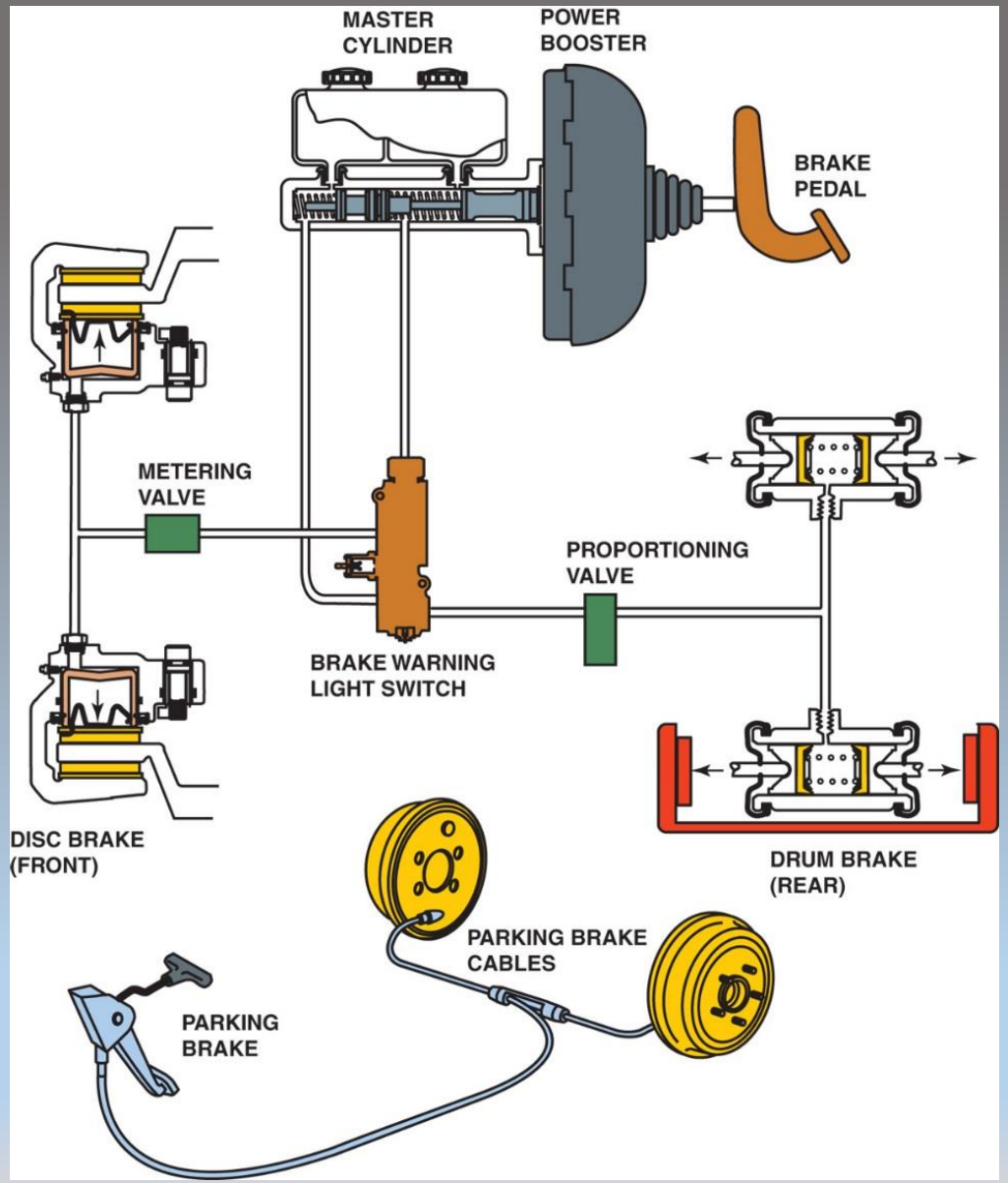
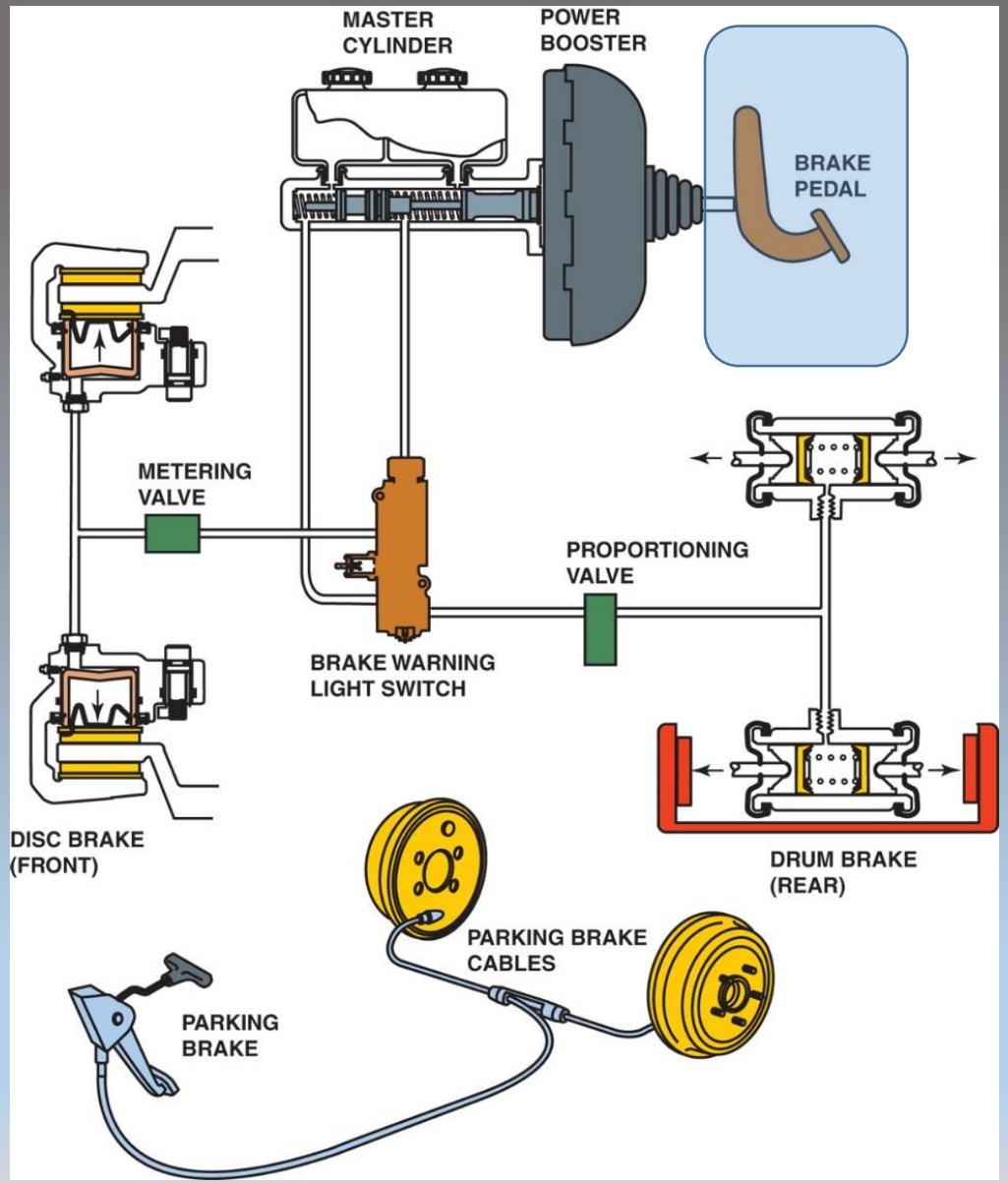
**majority of maintenance needs (brake job)

Typical brake system



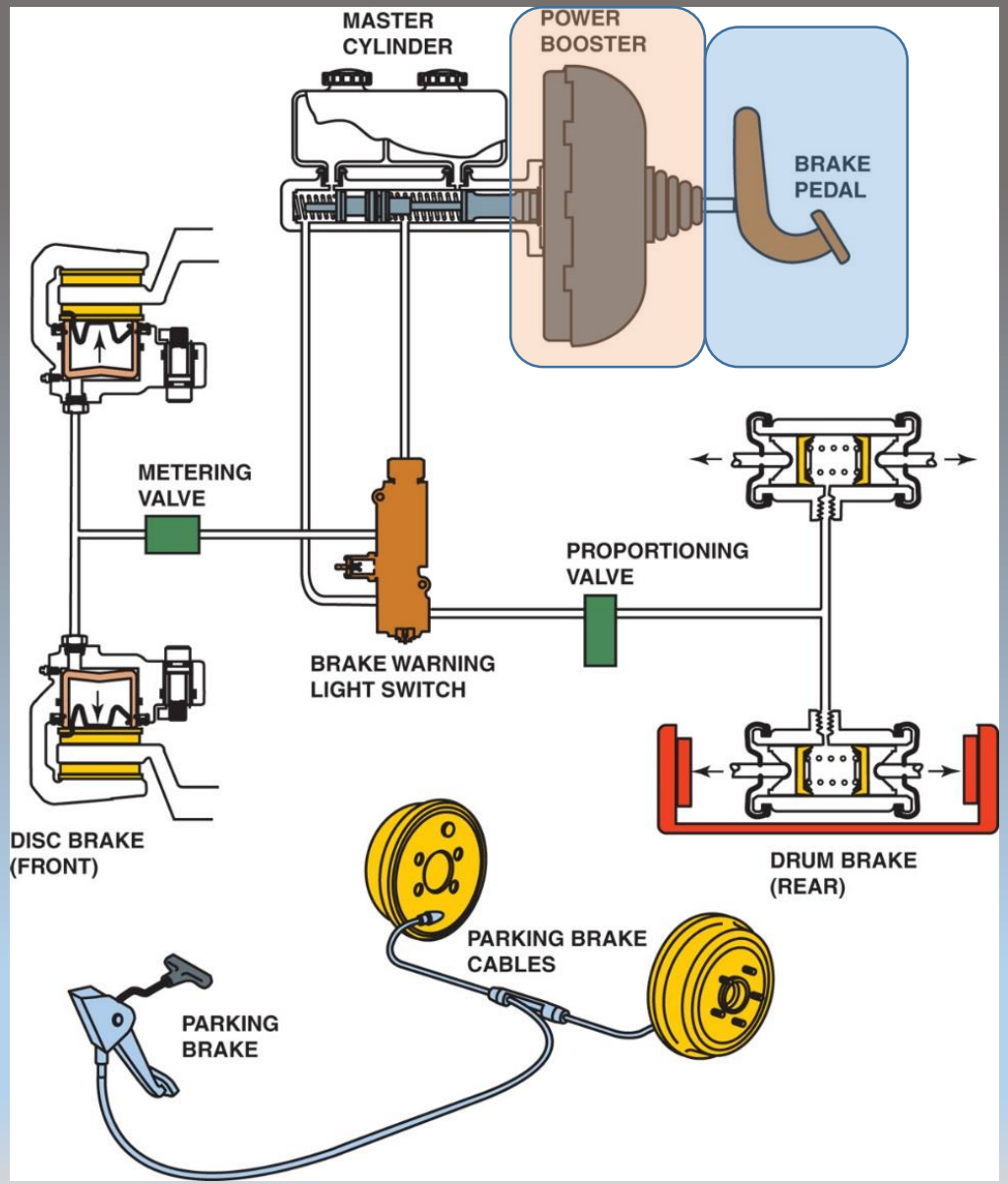
Typical brake system

Apply system



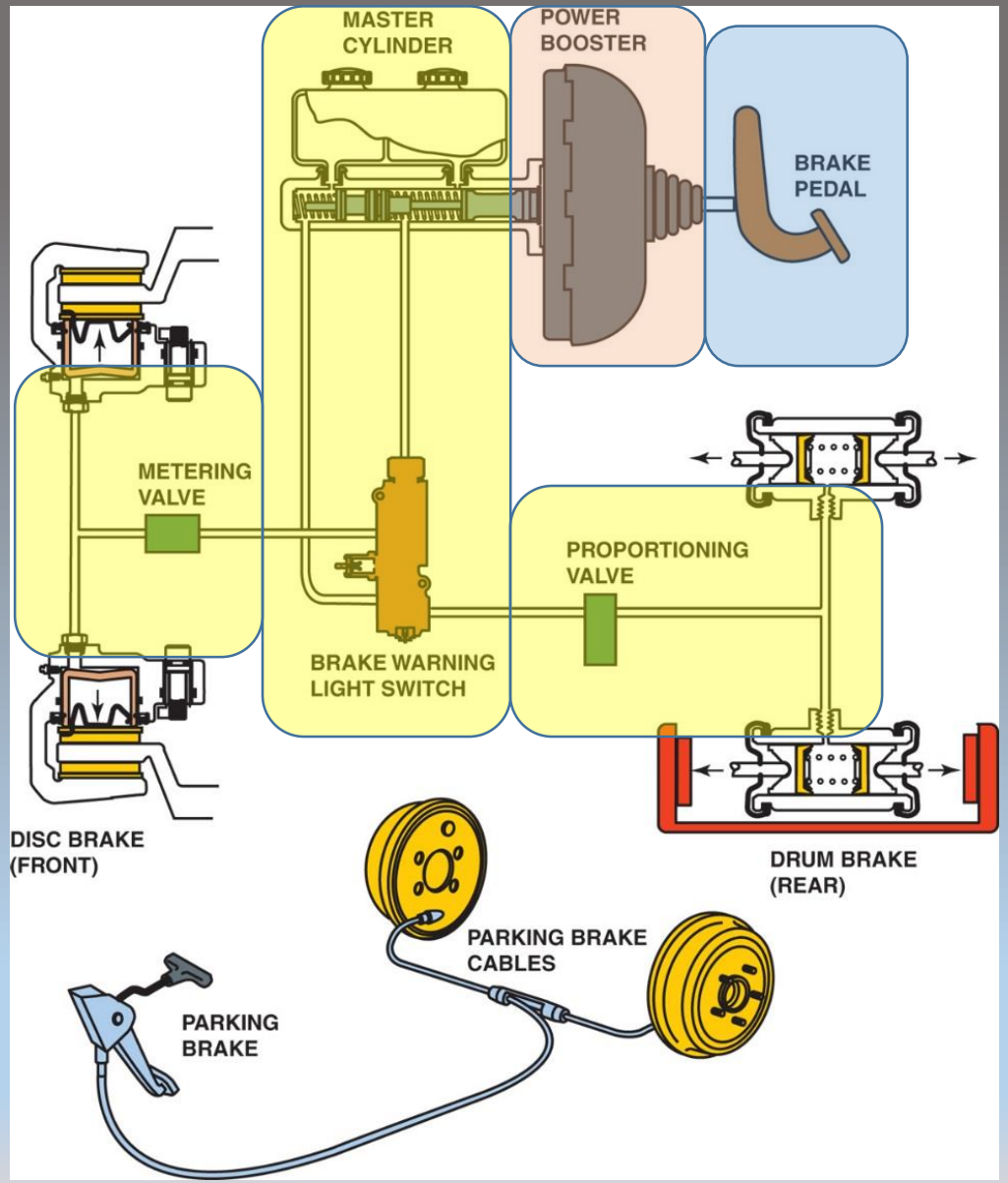
Typical brake system

Boost system



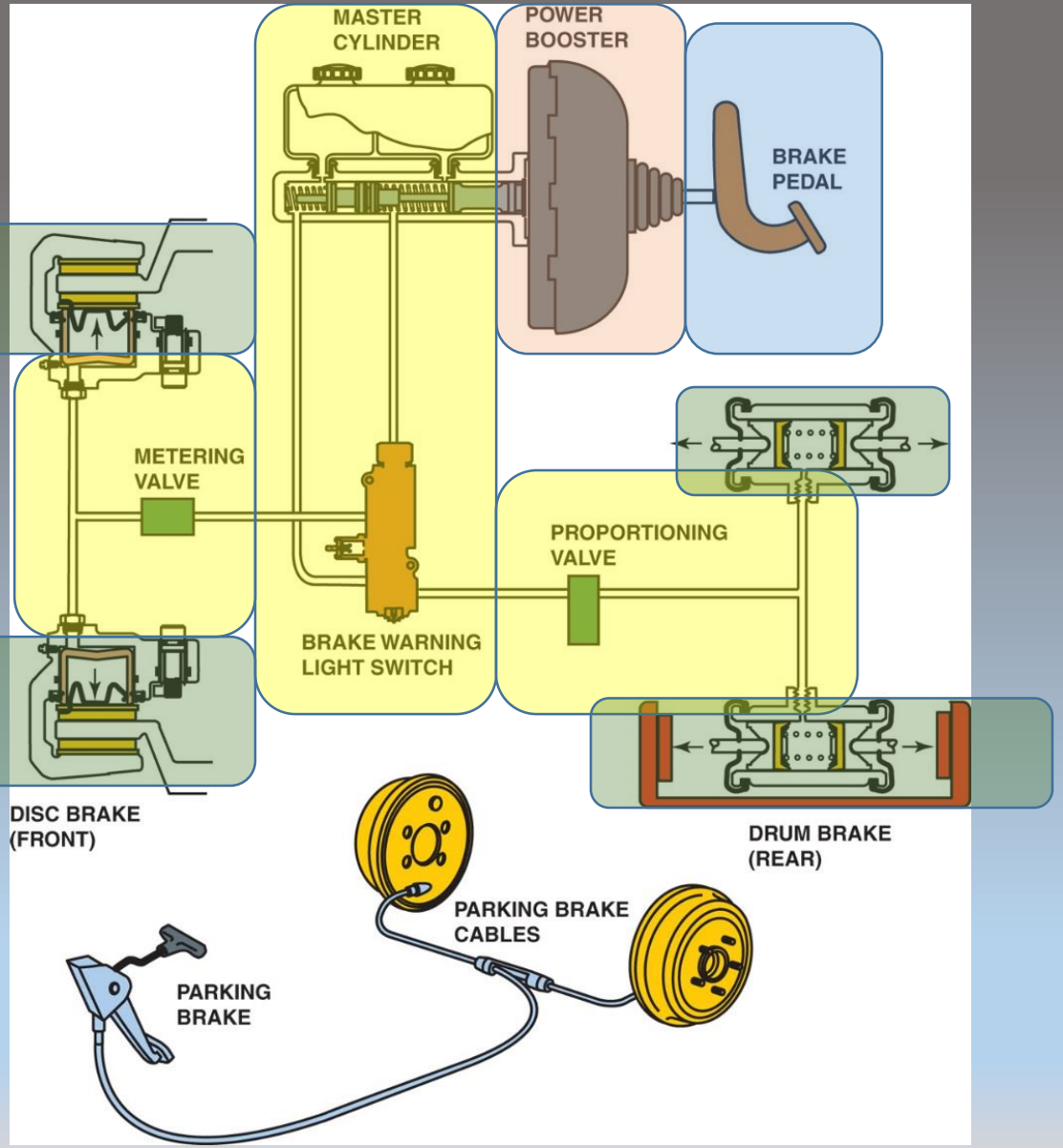
Typical brake system

Hydraulic system



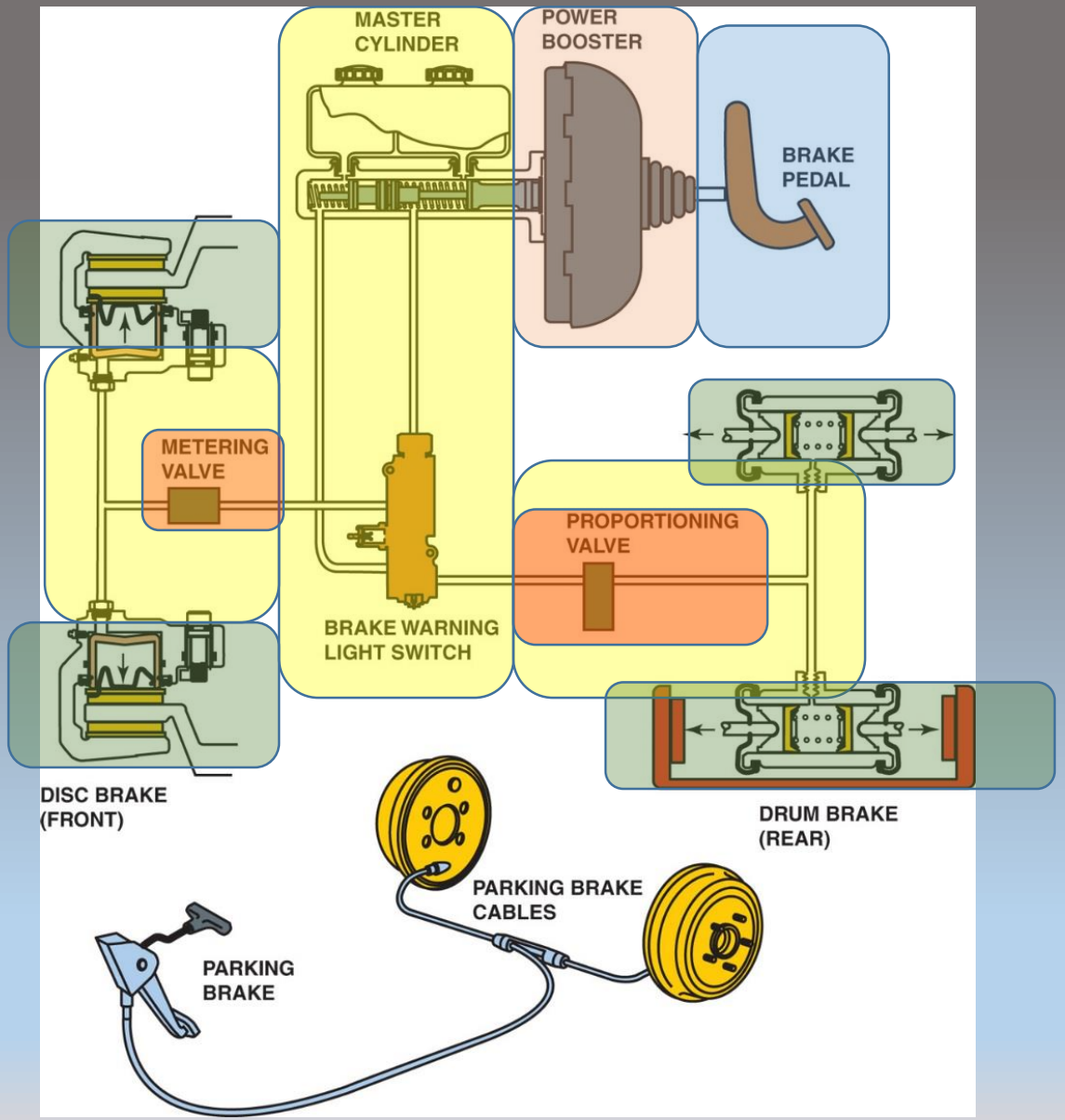
Typical brake system

Wheel brakes



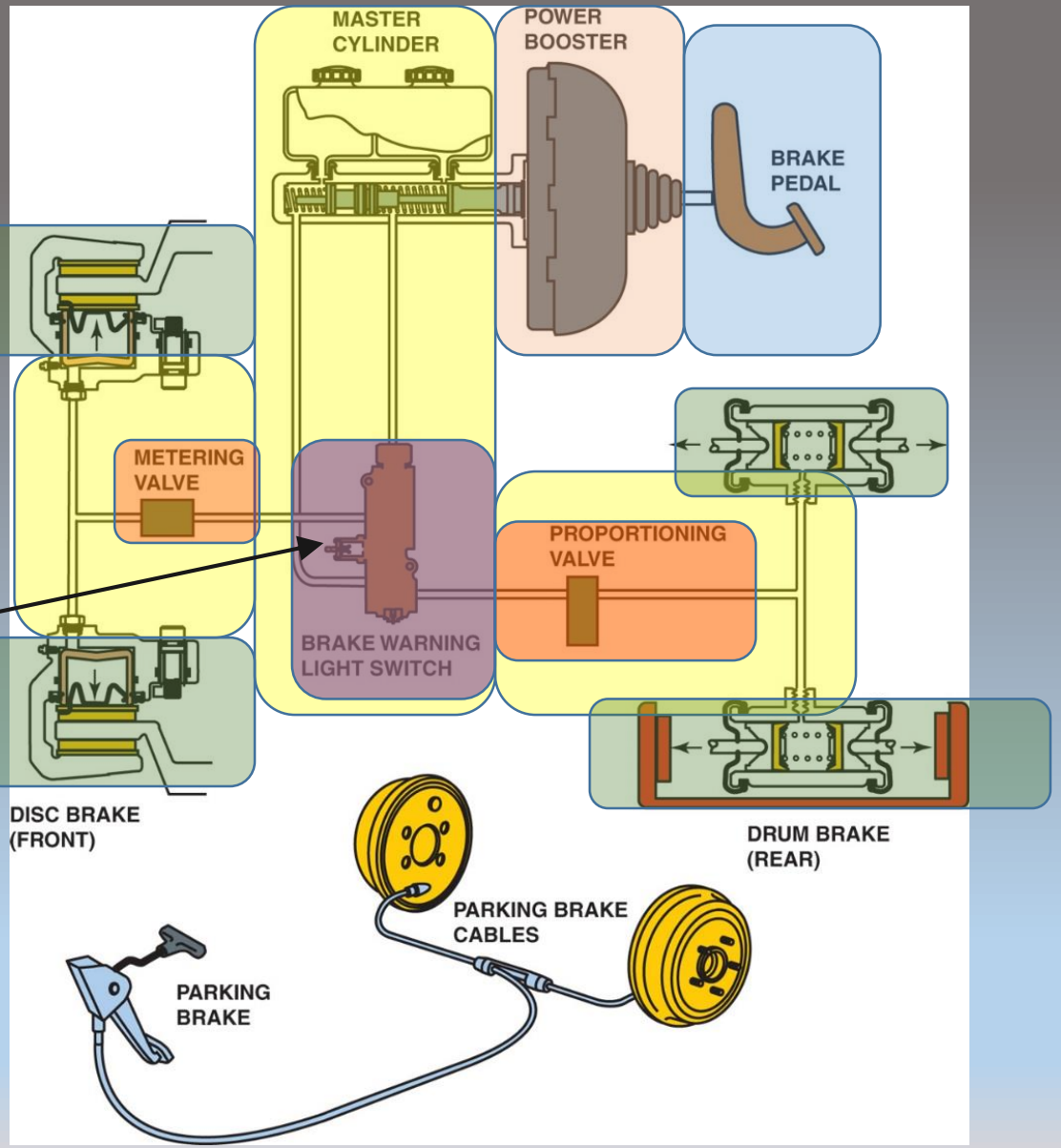
Typical brake system

Balance control



Typical brake system

Brake warning lights



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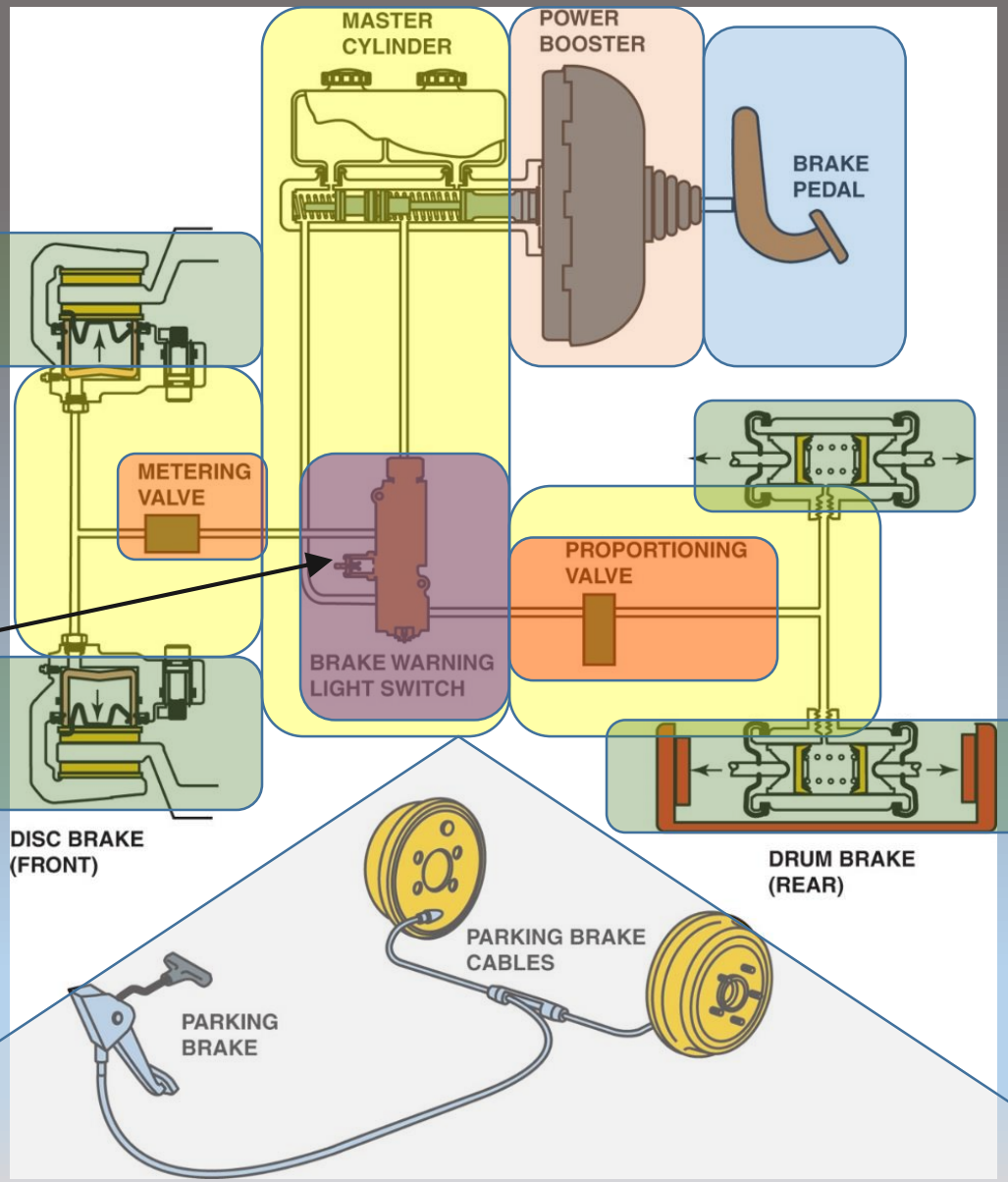

Parking brake

Categories of brake system

- **Apply system**
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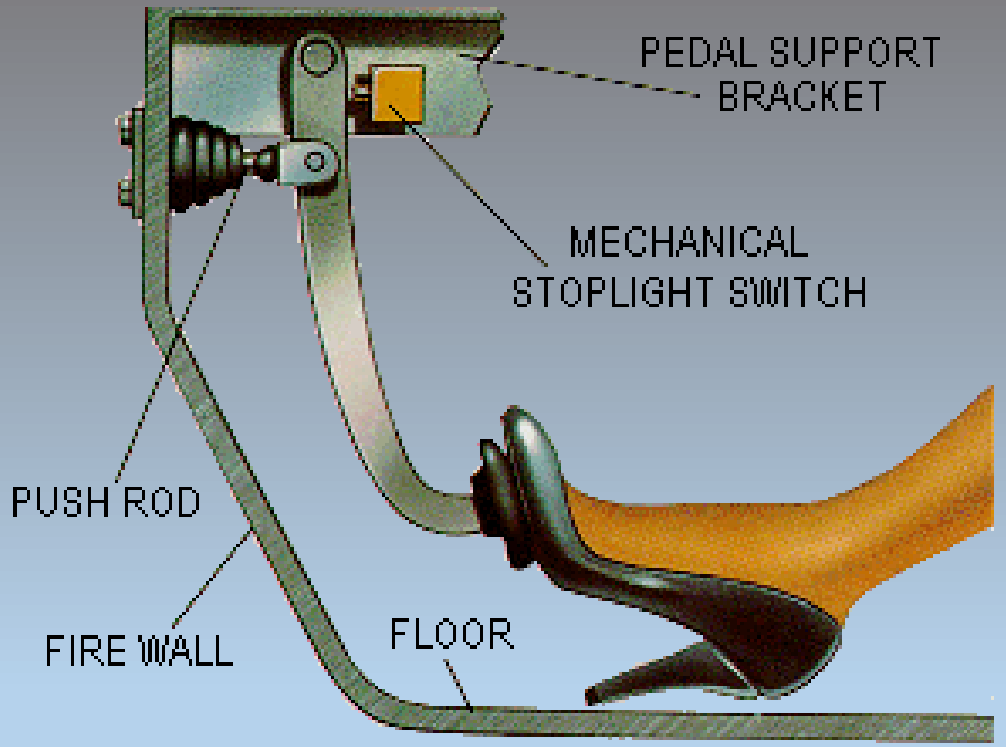
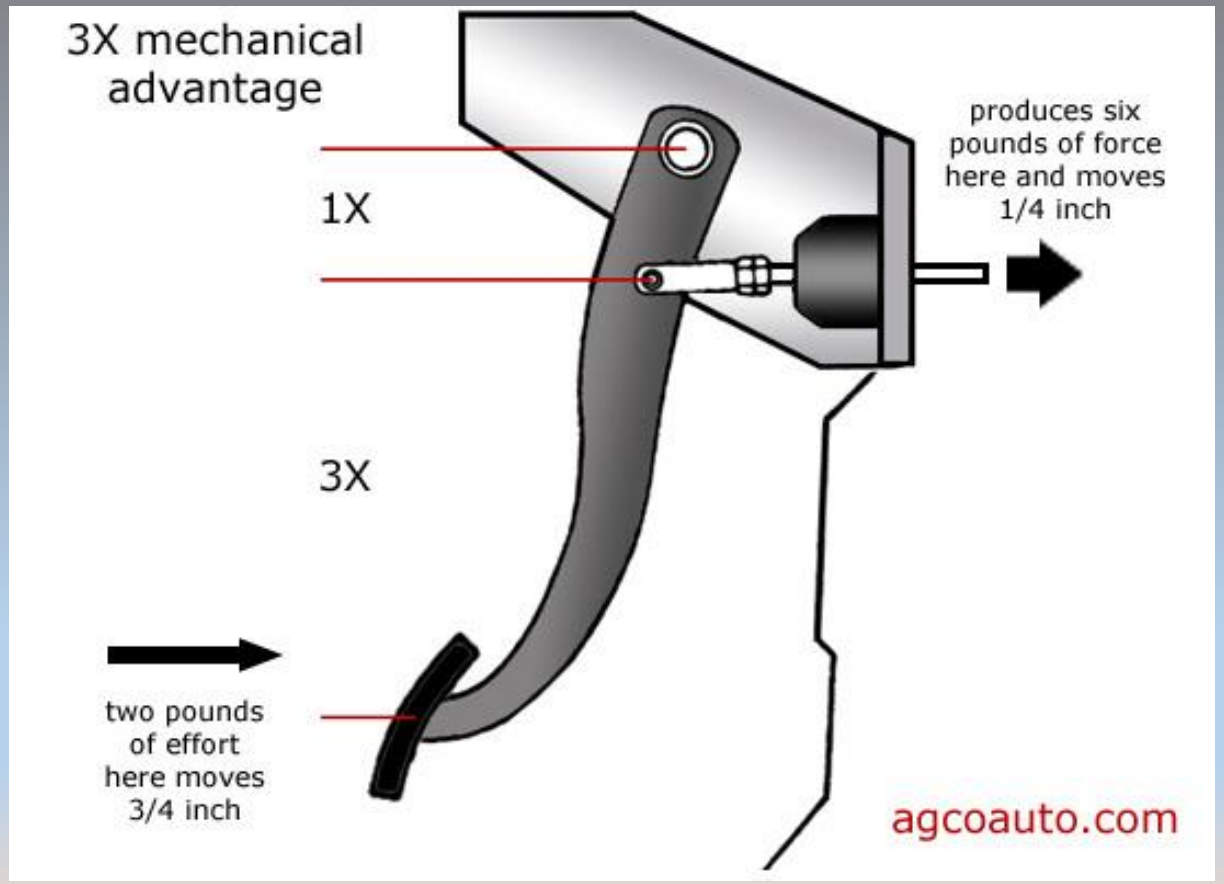
Apply system

- Drivers input
- Mechanical with a Fulcrum and Pivot
- Mechanical advantage
  - 3:1 power brakes
  - 5:1 manual brakes
  - Designed by engineers
- Very little to service needs

- Some late model vehicle will have power adjustable pedals

Apply system





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Boost system

- Multiplies the apply pressure
- All booster systems have a reserve for additional 1 or 2 stops
- Never disables manual brakes if booster fails
- Different types of power assist
  - Vacuum boost
  - Hydro-boost
  - Electro-hydraulic boost

Boost system Vacuum

Boost system Vacuum

- Uses *engine vacuum* as source of power to multiply driver input
- Uses an internal diaphragm to convert vacuum to assist energy
  - Single diaphragm
  - Double diaphragm
- Utilizes a one way check valve to keep vacuum for reserve
- Located before the master cylinder
- Most common boost system used
- Diesel engine has no vacuum??? or Turbo ??

Boost system Vacuum

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  - Single diaphragm
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- Utilizes a one way check valve to keep vacuum for reserve
- Located before the master cylinder
- Most common boost system used
- Diesel engine has no vacuum??? or Turbo ??
  - May have a additional vacuum pump
  - May use another type of boost system

Boost system Vacuum

Diesel and turbo engines do not provide a vacuum and may require the use of an additional vacuum source to utilize the Vacuum booster.

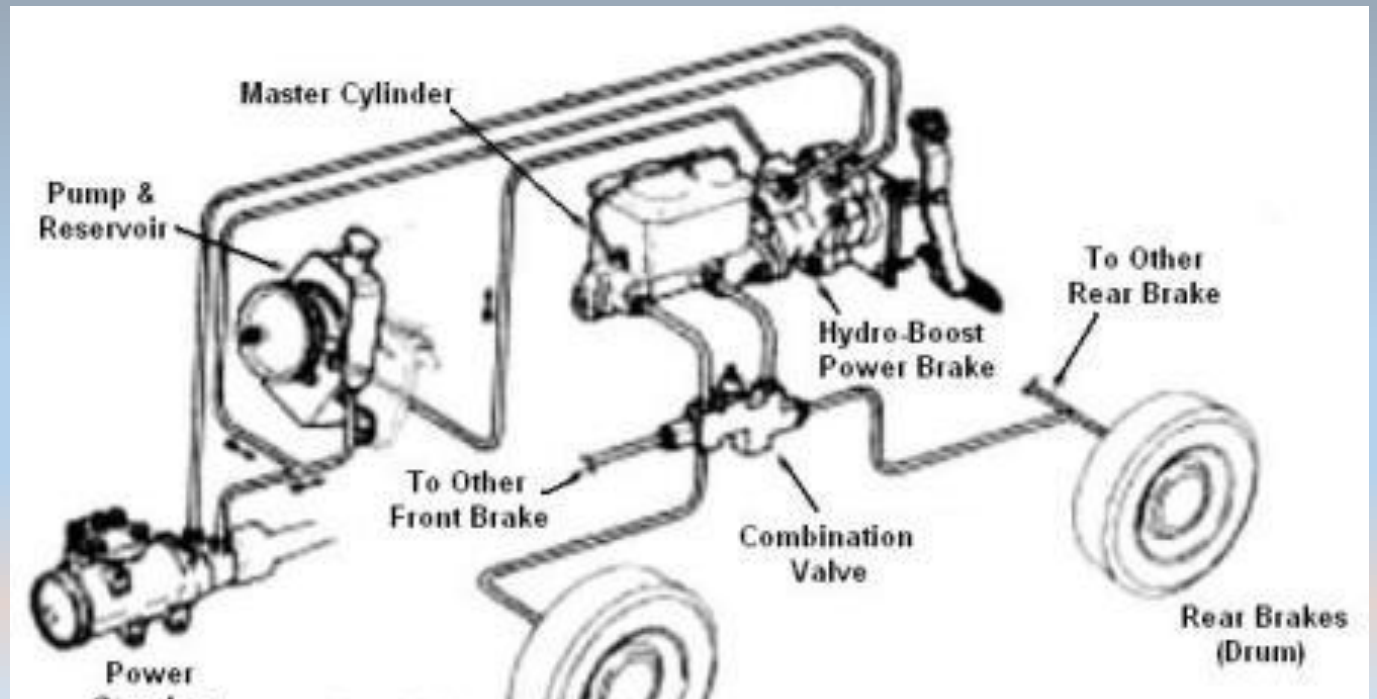
This is an example of a belt drive vacuum pump that some diesels may use

-or-

The other option is to use another type of power assisted boost system

Boost system Hydro-boost

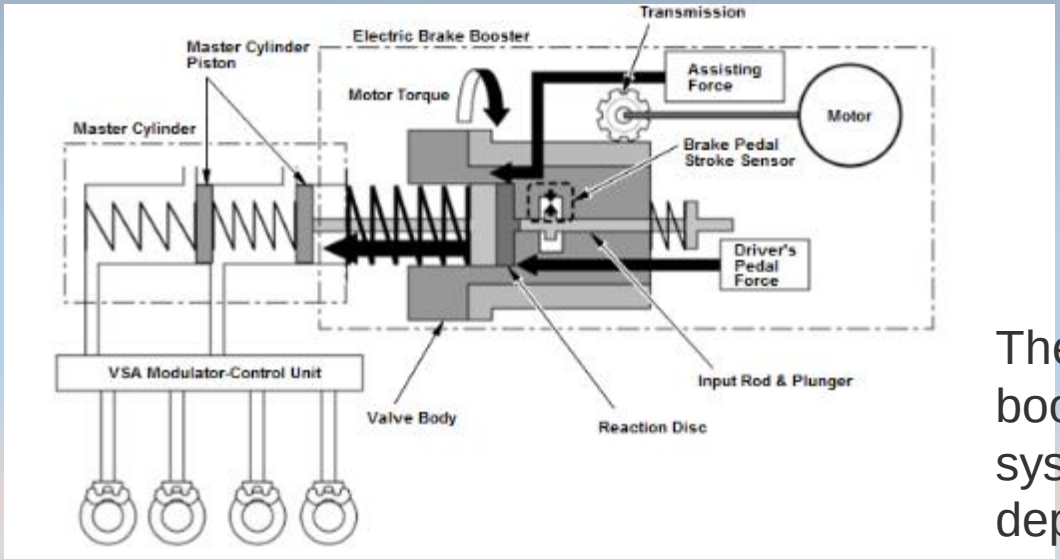
- Uses *hydraulic pressure* as source of power to multiply driver input
- Incorporates power steering hydraulic pressure
- Located before the master cylinder
- Used with diesel, turbo, heavy duty vehicles



Boost system
Electric or Electro-hydraulic

- Uses *electric motor* as source of power to multiply driver input
- Usually combined as part of master cylinder assembly
- Does not need vacuum or power steering sources

- Becoming more prevalent with NEW technology



The electric brake booster is an electromechanical brake booster that replaces a typical vacuum brake booster. This system provides stable braking performance that does not depend on vacuum supply. 2019 Honda Accord

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Hydraulic system

- Hydraulic principles
- Brake fluid
- Components
  - Master cylinder
  - Steel brake lines
  - Flexible brake hose
  - Brake calipers (disc)
  - Wheel cylinders (drum)
- Servicing
  - Bleeding brake fluid after component replacement
  - Brake fluid service as a maintenance
  - Brake fluid contamination

Hydraulic system Hydraulic principles

- Can NOT compress a liquid (like a gas)
- When compress a fluid, pressure change will occur at same rate in all directions (Pascals law)
- Multiplication of hydraulic pressure
  - Unequal area WILL increase the pressure and reduce the distance

  - **For example**
  - A master cylinder with ½" bore and a caliper with a 2" bore
  - BOTH have Same PSI (Pressure per Square Inch)
  - Caliper piston has 4 times more area in inches = 4X PRESSURE
  - Caliper piston will only move ¼ the distance

Hydraulic system Brake fluid

- Specific fluid qualities needed
  - High boiling point to resist effects of heat
    - If boils will get air in system
  - Low freezing point
  - Compatible with rubber parts in the brake system
- Poly-glycol based (non petroleum product)
- Hygroscopic
  - Affinity for water
  - Wet fluid lowers boiling point
- Types
  - Dot 3
  - Dot 4
  - Dot 5.1
  - Dot 5
  - Don’t mix fluids

Hydraulic system Brake fluid

- Types

boiling points	dry	wet
• Dot 3	401 Degrees F	284
• Dot 4	446 Degrees F	311
• Dot 5.1	500 Degrees F	356
• Dot 5	500 Degrees F	356

  - Silicone based
  - Non-hygroscopic
  - Expensive cost
  - Does Not bleed well

- Don’t mix fluids

Hydraulic system Components Master Cylinder

- Single piston master cylinder
  - Early braking systems
  - Only one hydraulic channel
  - Loss of **all** brakes when hydraulic failure

- Double piston master cylinder
  - Mandated by law since 1968
  - Loss of **half** of brakes when hydraulic failure
  - Hydraulic split in system

Hydraulic system

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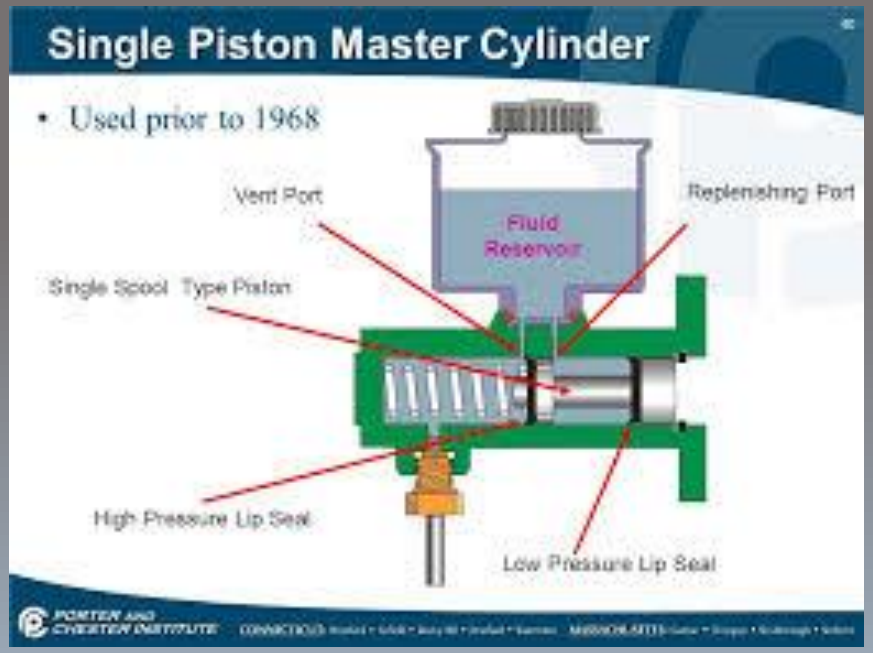

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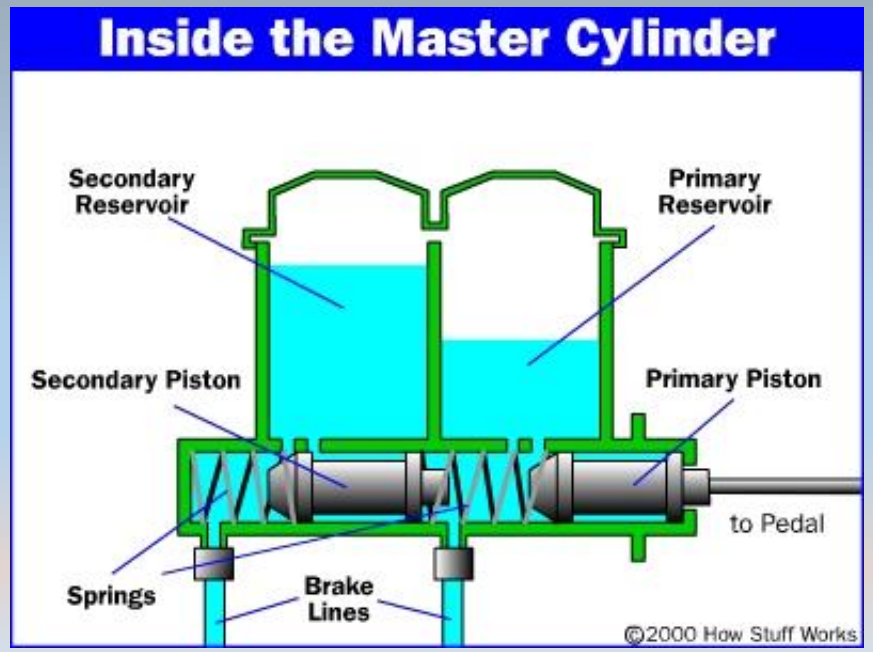
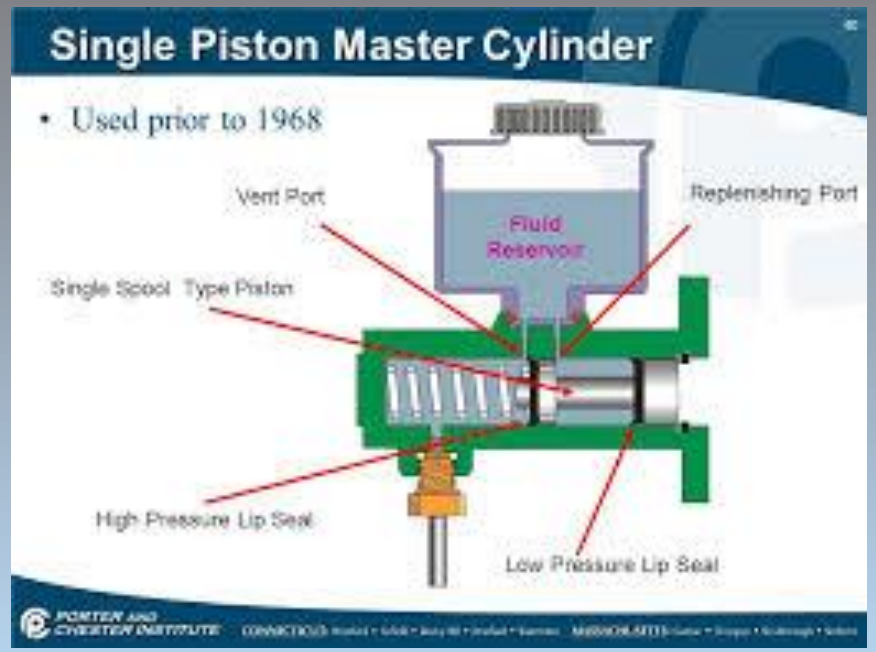
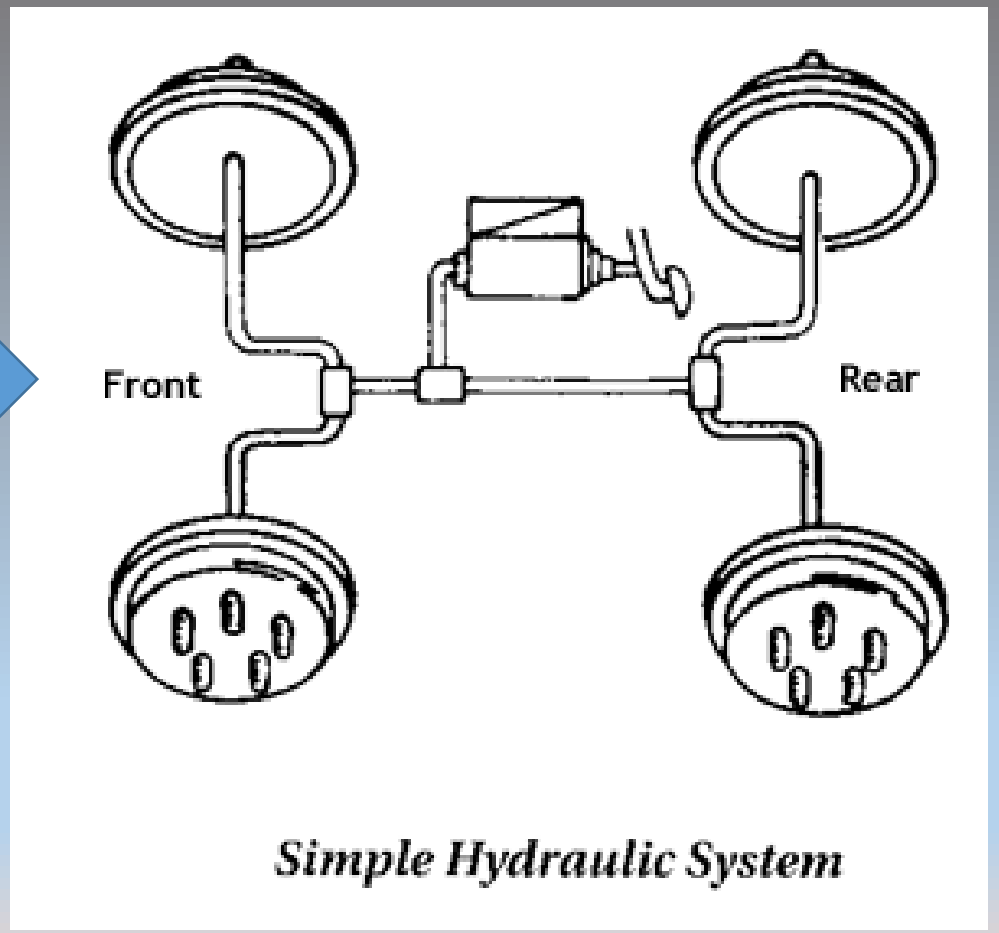


Hydraulic system

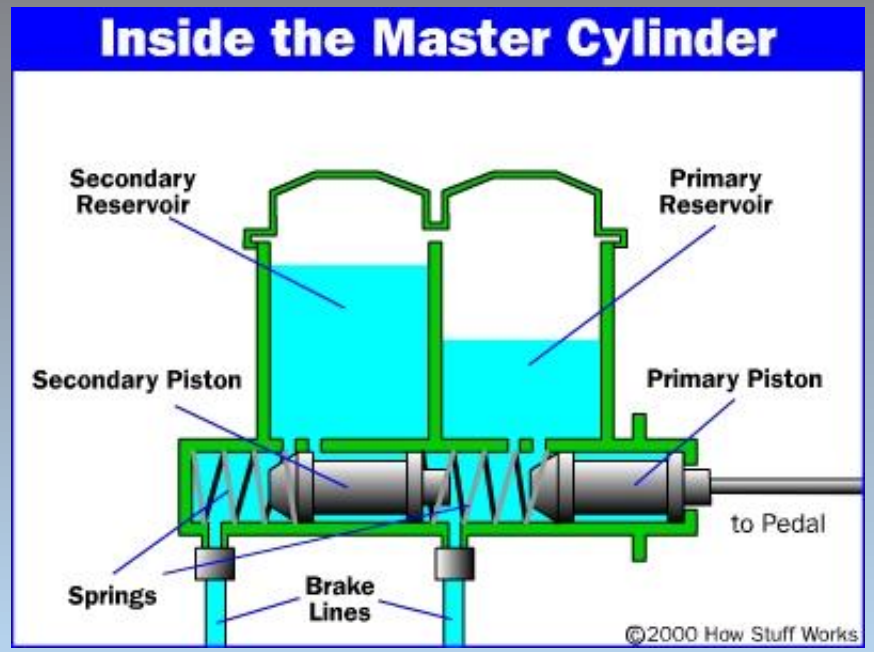
Master cylinder Hydraulic split

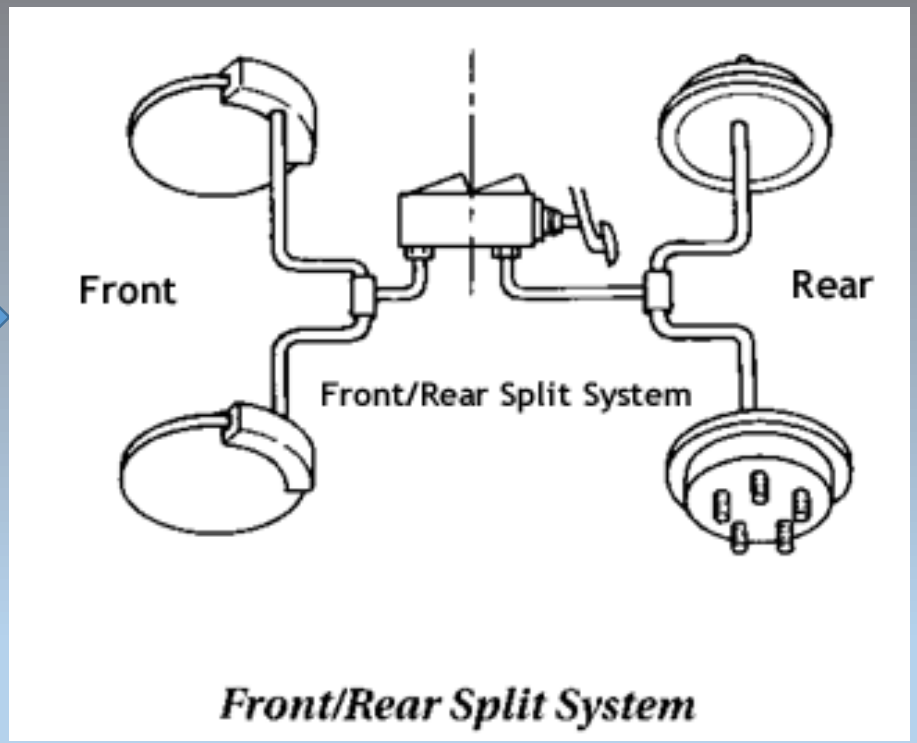




Hydraulic system

Master cylinder Hydraulic split





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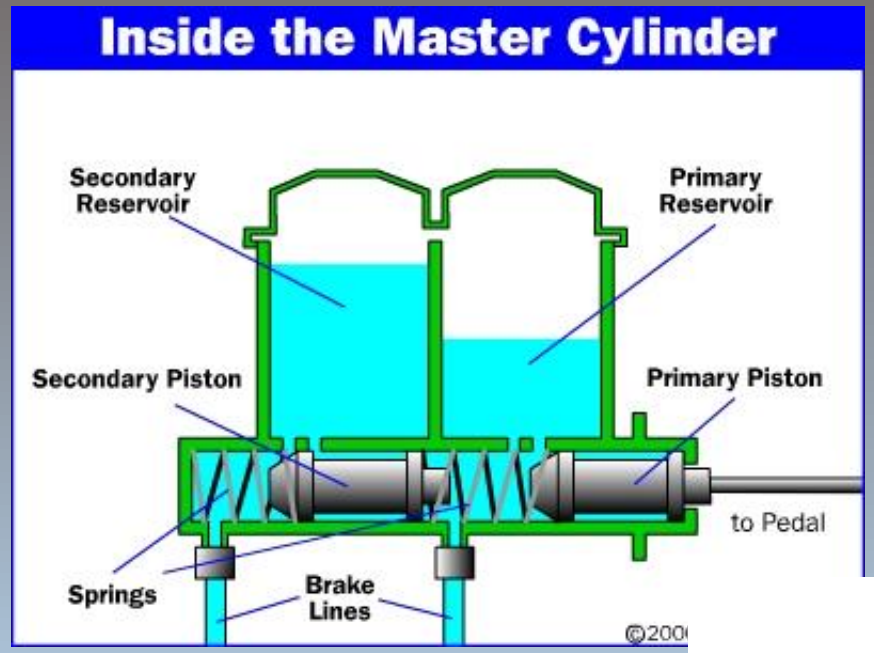
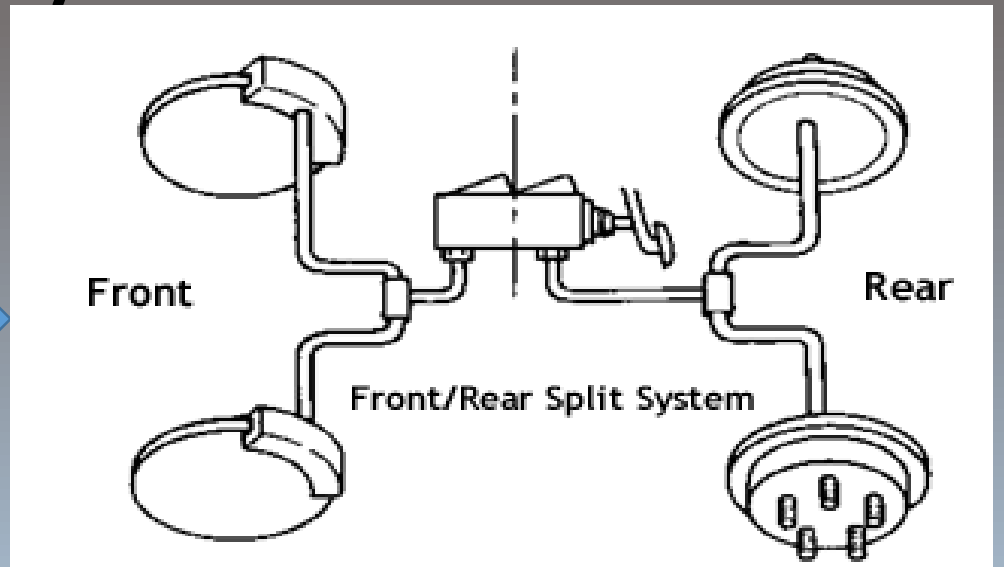
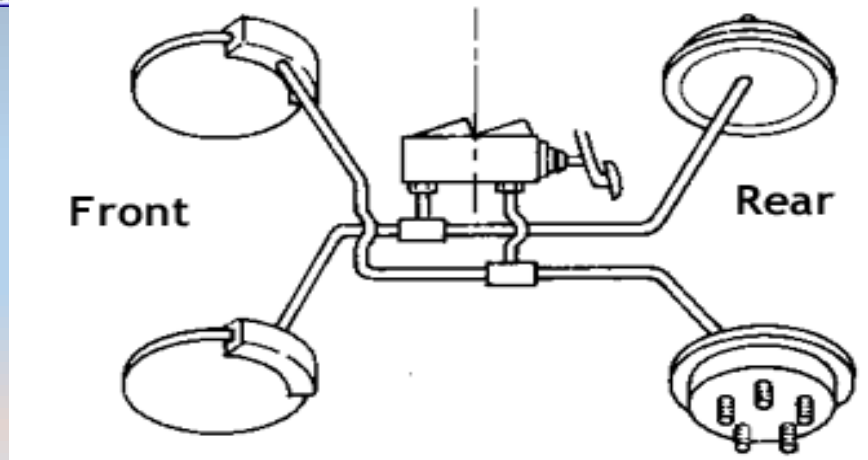


Master cylinder Hydraulic split



Diagonal split system



Front/Rear Split System

Hydraulic system Components brake lines

- Purpose to direct fluid to the wheel brakes
- Double wall steel tubing
- ALL brakes line require special flare to hold PSI
  - Double flare
  - ISO ball flare (bubble flare is commonly referred to)
  - NEVER use compression fittings

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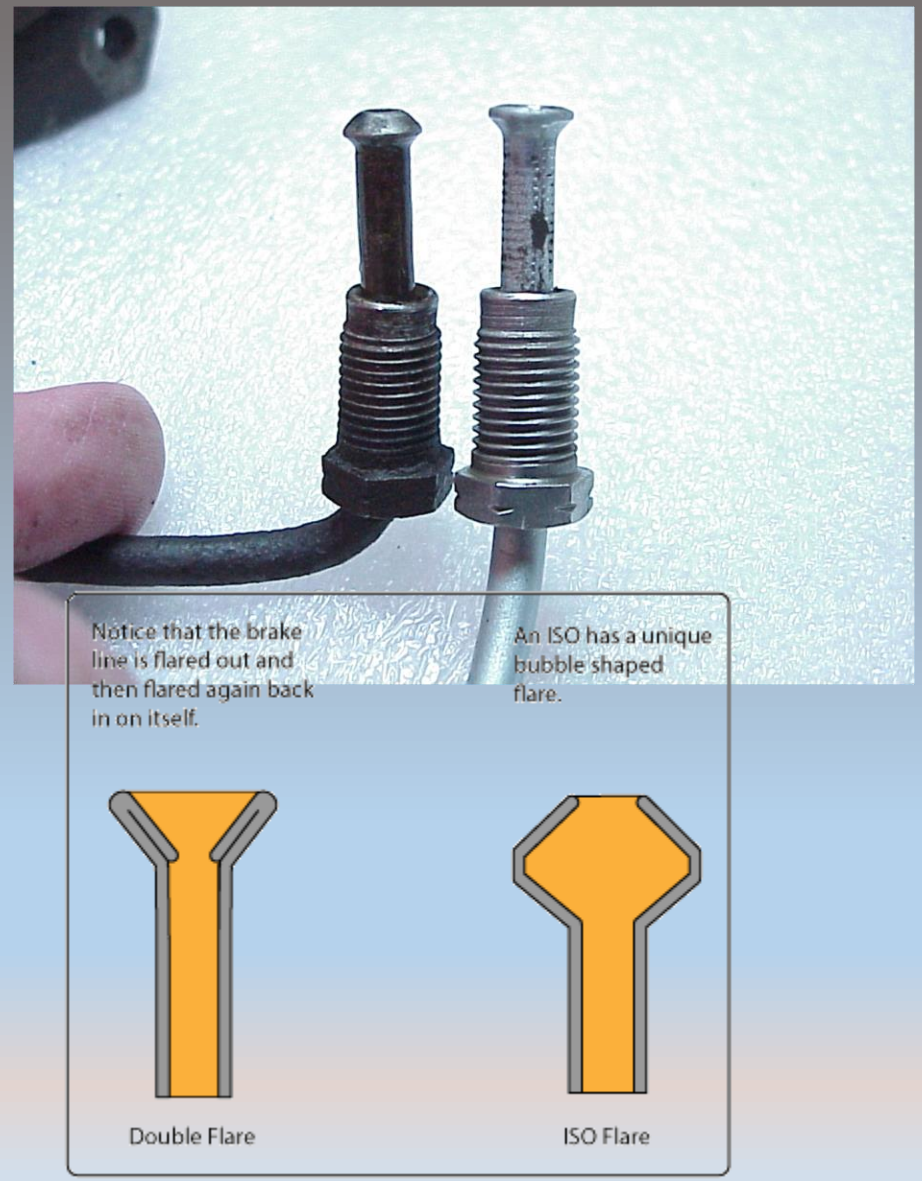

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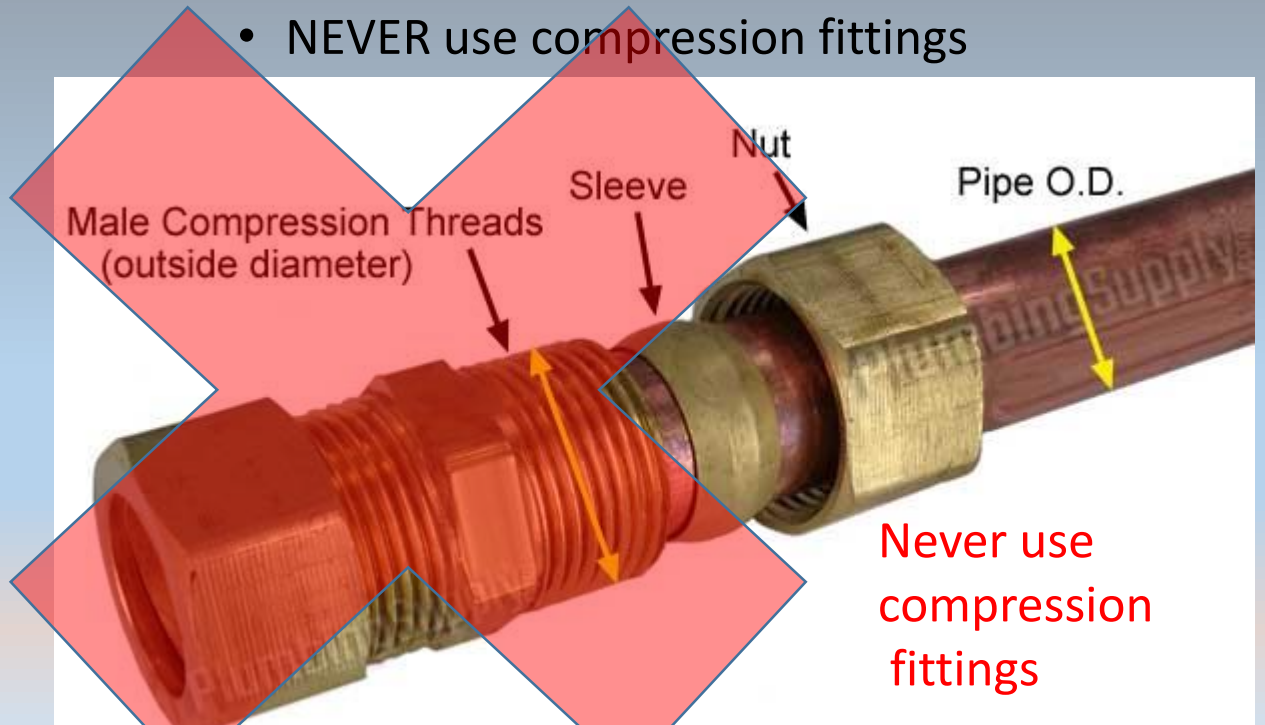
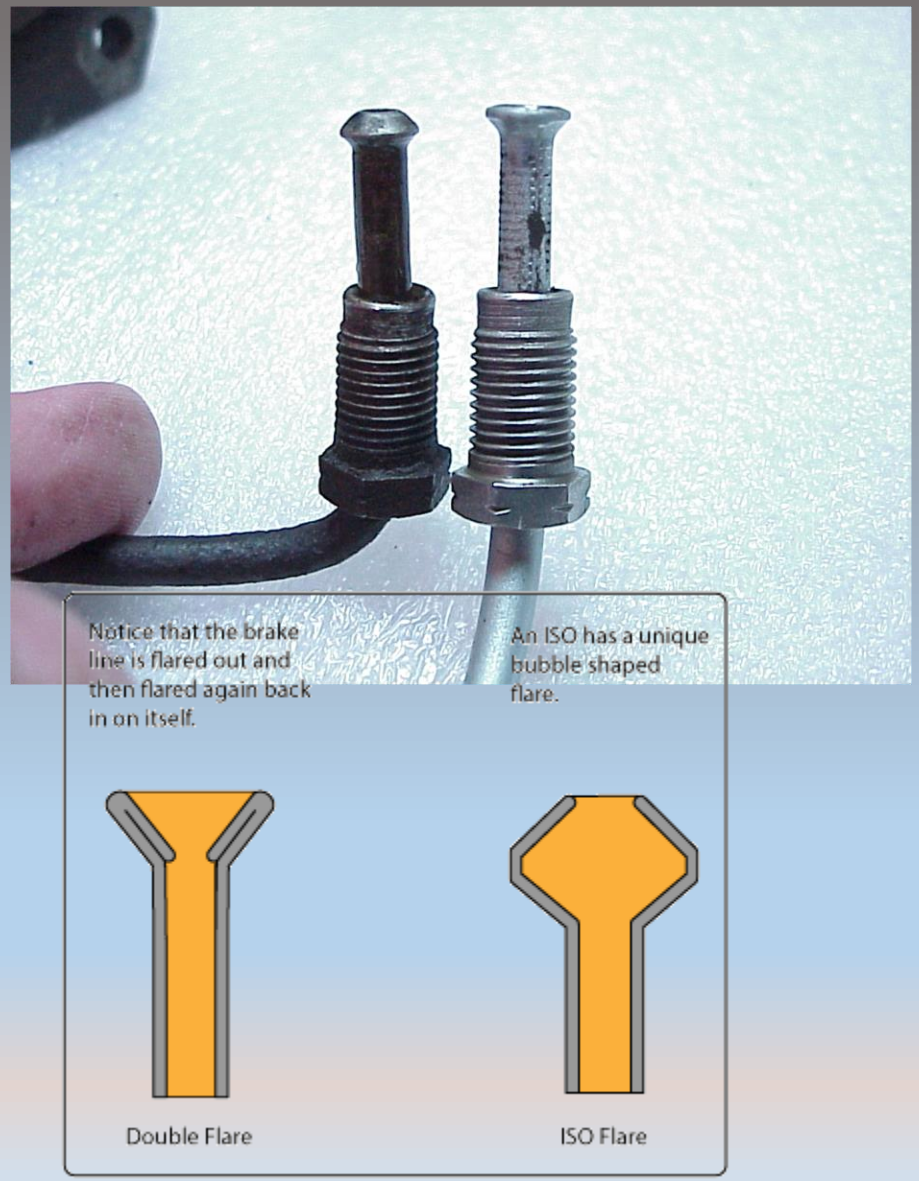




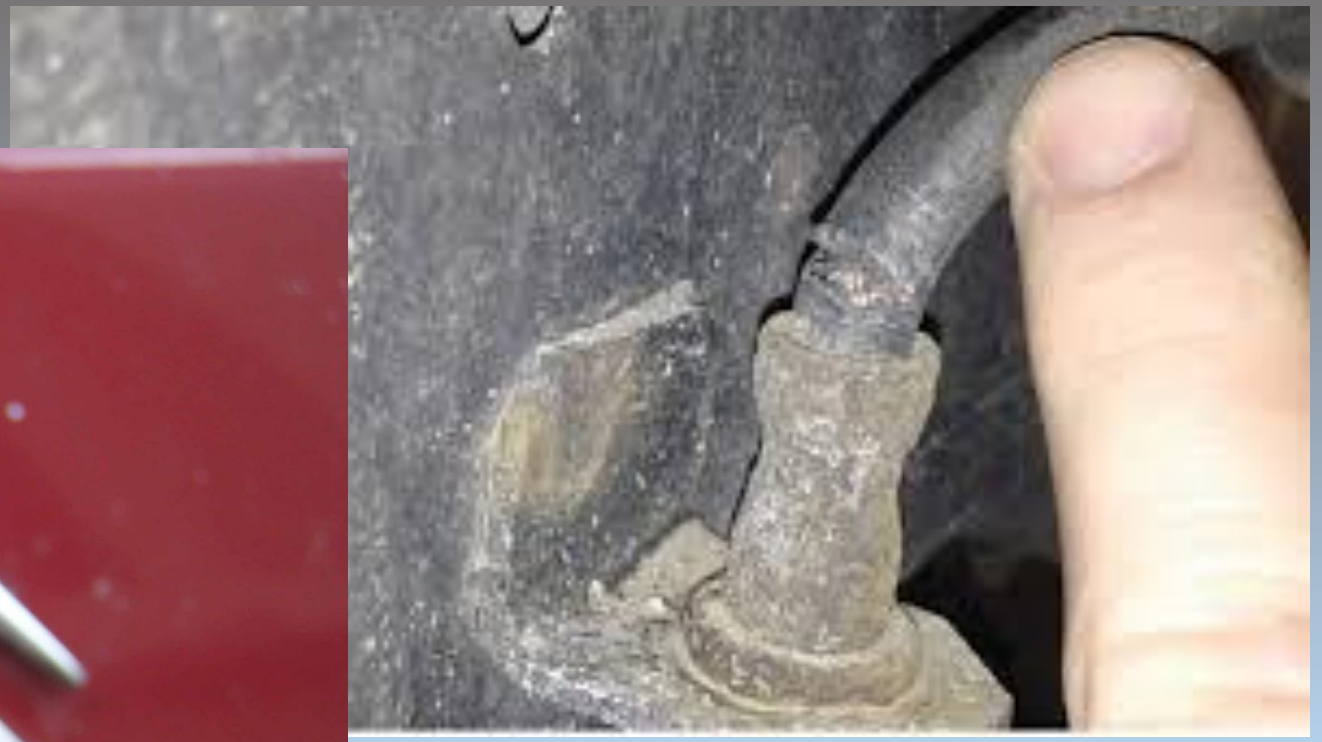
Hydraulic system Components Brake hose

- Flexible, allows for suspension travel and steering
- Used at each wheel
- High pressure woven/braided material outer
- Inner liner to hold Brake fluid
- Must be ordered by specific vehicle

Hydraulic system

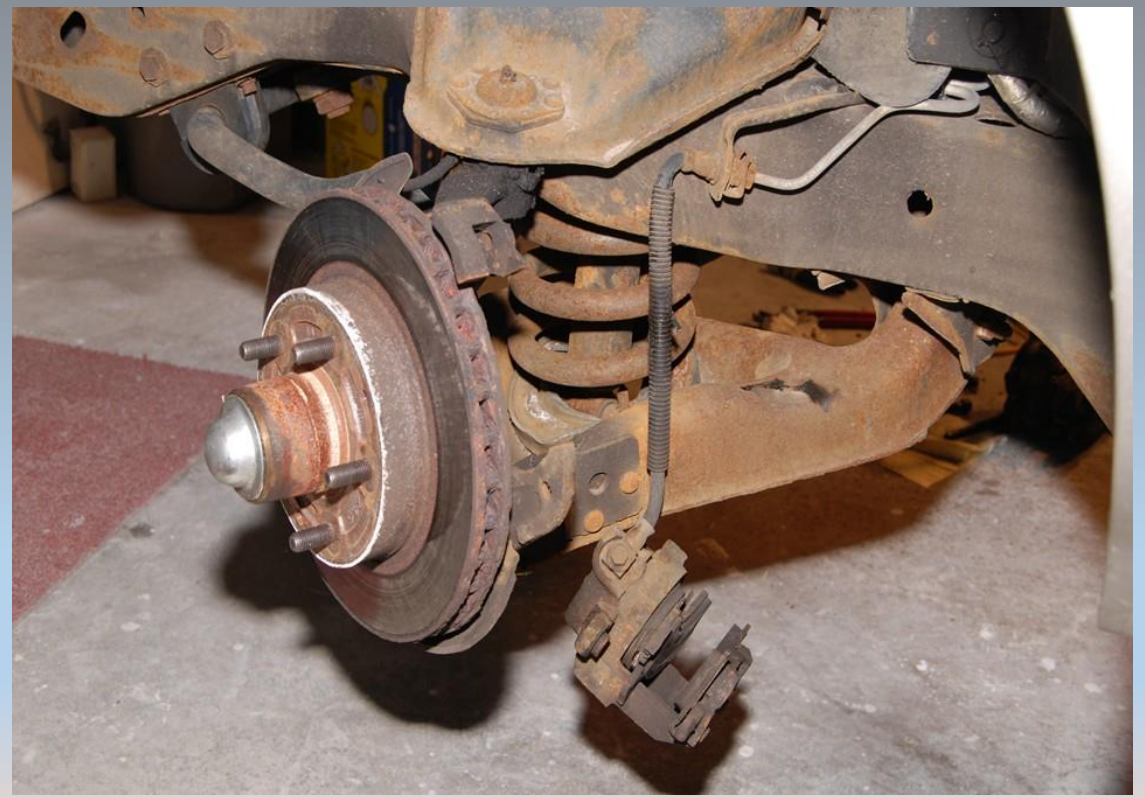
Components Brake hose

- FAULTY



Hydraulic system Components Brake hose

- When servicing the brake system hydraulic components
  - **Never** pinch off a brake hose
  - **Never** use hose to support weight



Hydraulic system Components Brake hose

- Specialty tools for hose pinch. NOT recommend at ALL
- Potential internal damage to brake hose
- What can happen when hose has internal damage ???
  - No visible damage---hard to diagnose
  - Internal one way valve
    - Can cause brake pull
    - Wear brake pads prematurely

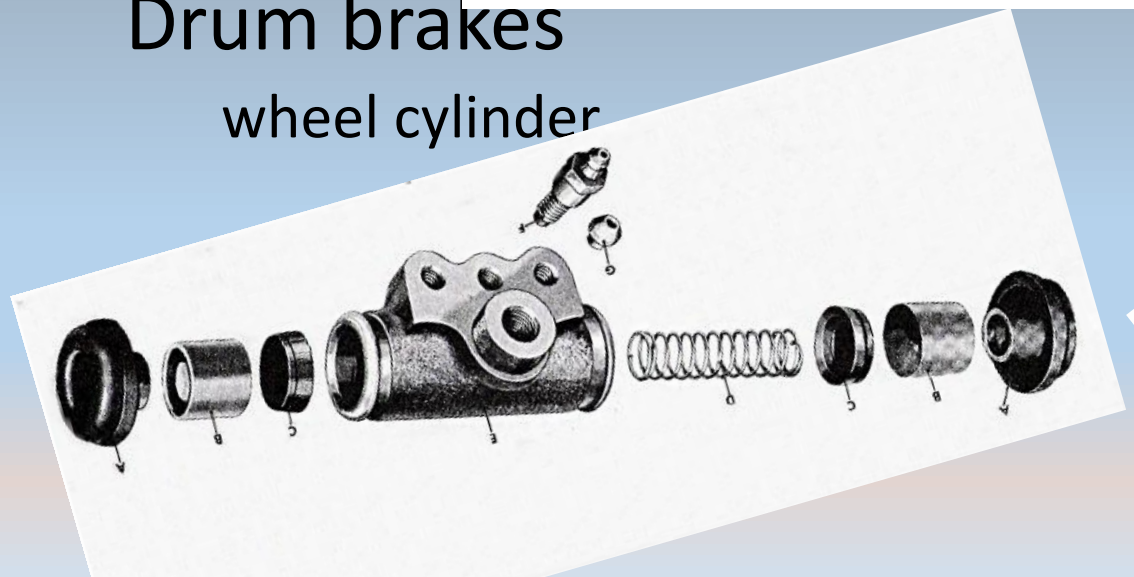
Hydraulics components

Disc brakes

caliper

Drum brakes

wheel cylinder



Hydraulic system servicing

- Brake fluid will need replaced when service to hydraulic system
- Bleeding required any time hydraulic part is replaced
  - Trapped air must be removed any time the hydraulic system is opened
- Symptoms of air in hydraulics
  - Soft spongy pedal feel
  - Have to pump up to get hard pedal

Hydraulic system servicing

- Brake fluid service as a maintenance
  - Some manufacturers recommend at a set miles
  - Brake fluid can get wet and boil during time of heavy braking
  - Dirty and discoloration can be misleading
  - Test strips to measure brake fluid
  - Contamination of fluid
    - Moisture is bad, can happen if cap is loose missing
    - Metallic contamination, indicates wear of hydraulic piston and parts
    - Oil contamination—needs immediate attention

Hydraulic system servicing

- Oil contamination
  - Usually occurs during fluid top off - Gets mixed with wrong fluid
  - Water/Oil based fluids
  - Customer concern of unusual and poor braking
  - Drastic Swelling of all rubber in hydraulic system
    - Can cause MAJOR damage and lack of braking in both splits
    - First sign is master cylinder cap wont fit

Oil contaminated brake fluid result

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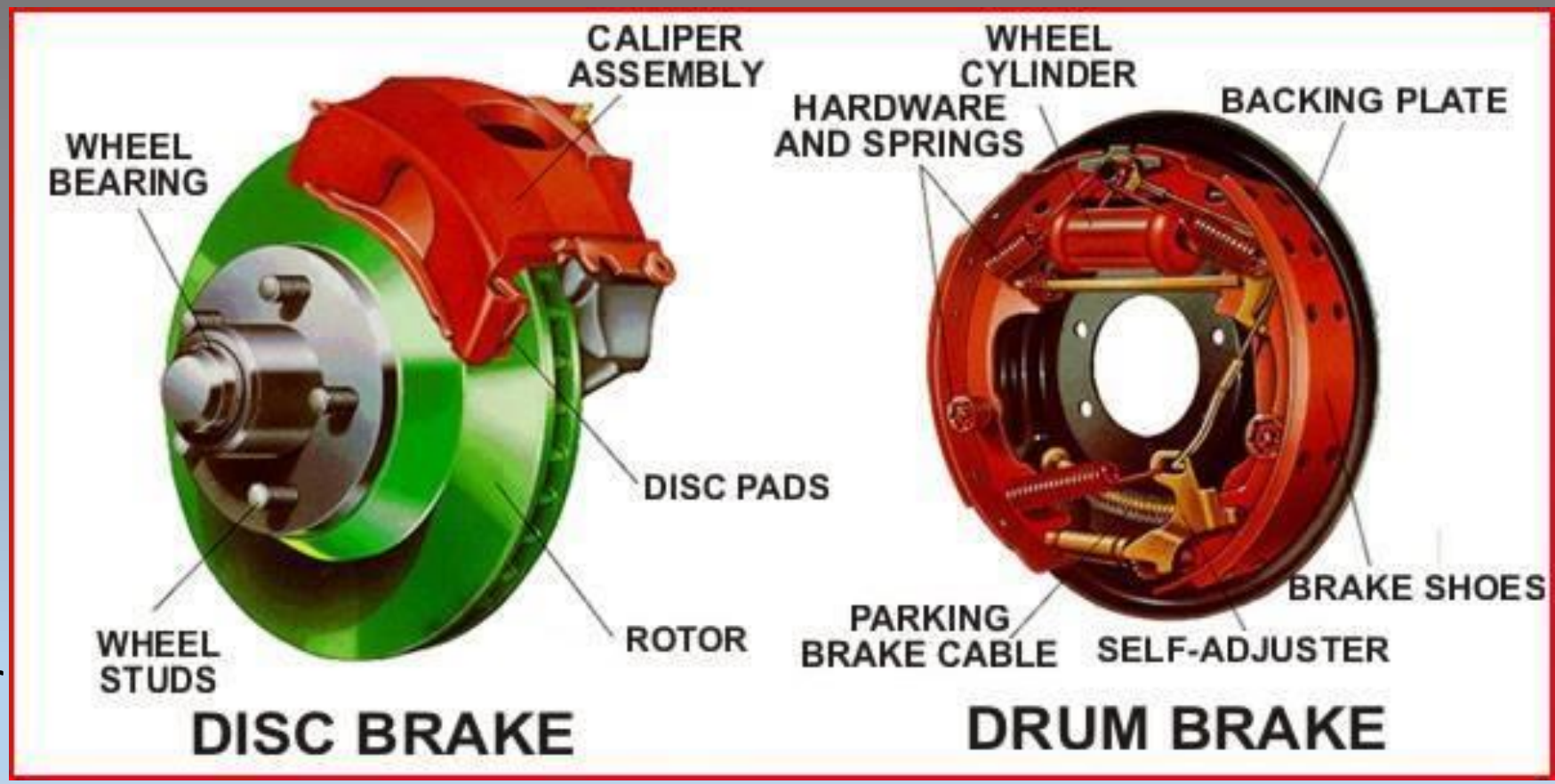
Wheel brakes

- Starts with hydraulic component to do the work
- Converts back to a mechanical movement that applies the friction material (stationary) to the rotor (moving)
- Releases heat as by product
- Components
  - Hydraulic
    - Caliper
    - Wheel cylinder
  - Sacrificial wearing parts
    - Brake shoes
    - Brake pads
    - Rotors
    - Drums (secondary)
  - Wheel bearing and hub

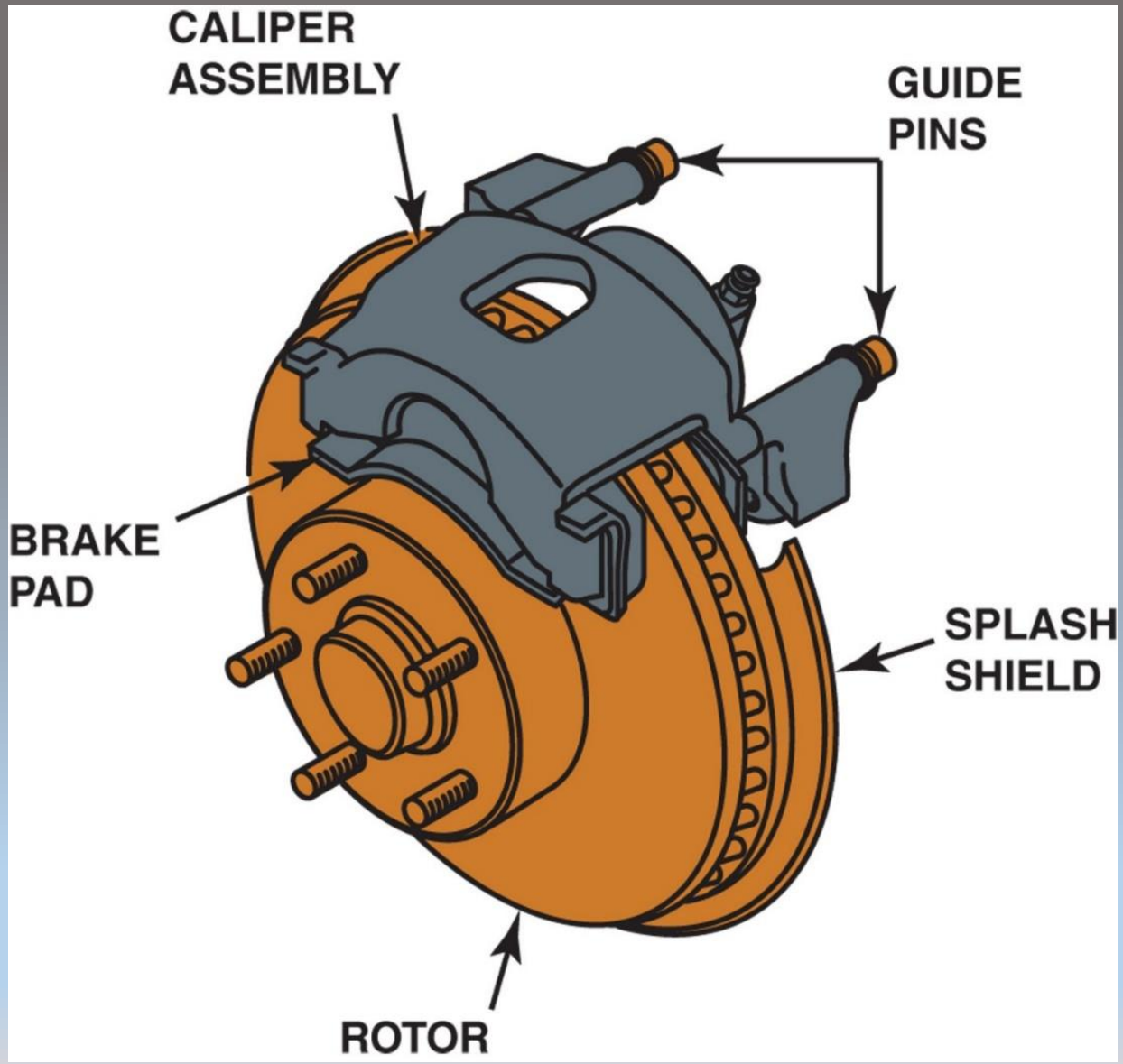
Wheel brakes components

Disc brakes
- caliper
- rotor
- brake pad

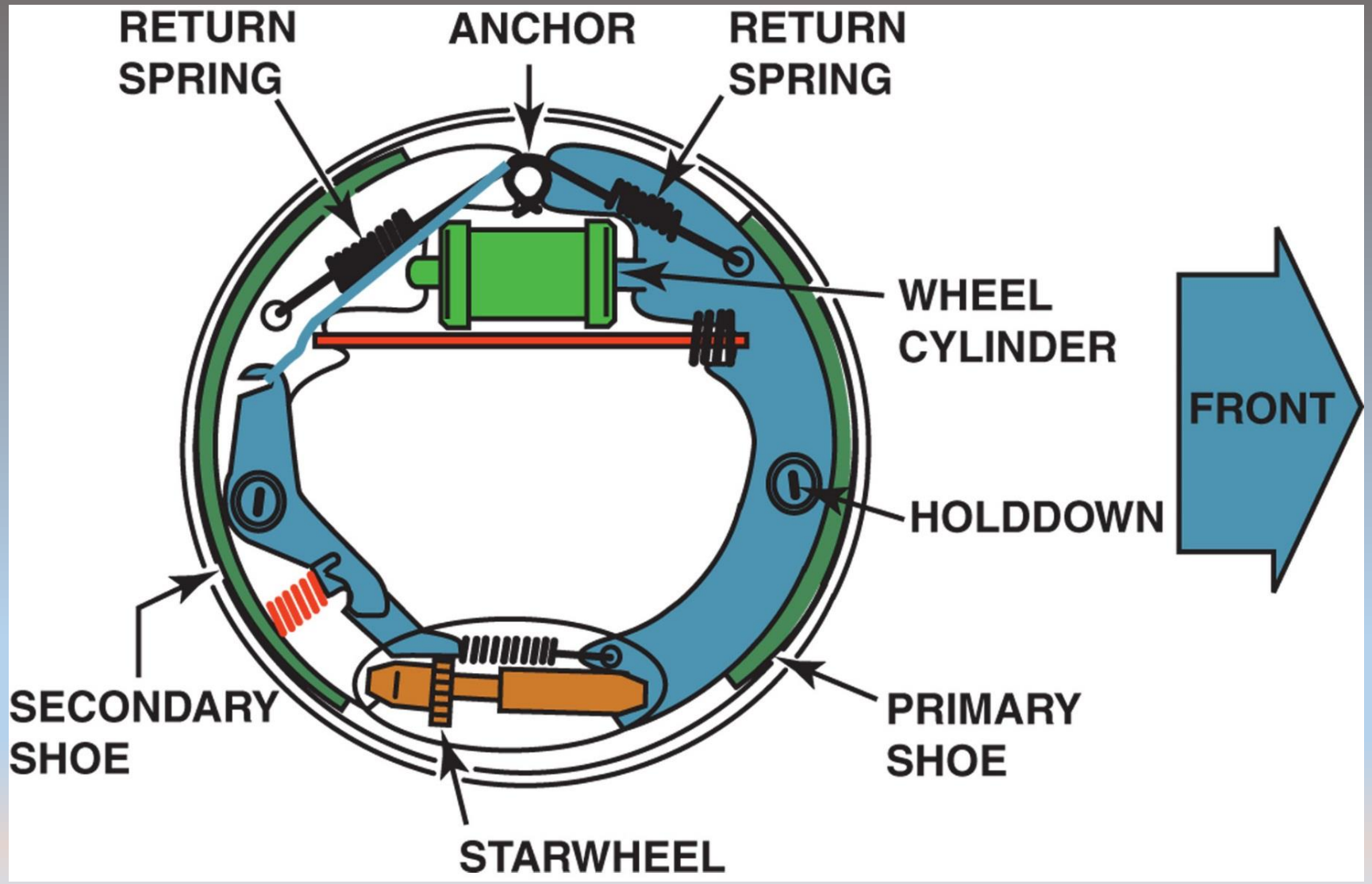
Drum brakes
- wheel cylinder
- drum
- brake shoe



Disc brakes



Drum brakes


RETURN SPRING
ANCHOR
RETURN SPRING
WHEEL CYLINDER
FRONT
HOLDDOWN
SECONDARY SHOE
PRIMARY SHOE
STARWHEEL

Wheel brakes service

- Referred to as a “Brake Job”
- Sacrificial wearing parts
  - Pads and shoes wear over time
  - Rotors and drums wear
- Does every brake job include the same service?
  - Some replace just pads/shoes
  - Some machine rotors
  - Some replace rotors
  - Some will inspect/adjust and lubricate parts for proper operation
    - This is crucial to service life and wear
    - Most shops will not take the time
- Best practice is to restore to FACTORY BRAKING as designed

Brake rotor service

- Machine a rotor
- Turn a rotor
- Resurface a rotor
- Truing a rotor
- ALL THE SAME THING

Wheel brakes service BRAKE JOB

- Replace Brake Pads
- Inspect for Irregular pad wear
  - Could indicate other problems

Wheel brakes service BRAKE JOB

- Replace Brake Pads
  - When? Why?
  - Before damage…grinding brakes
  - Not all pads have rivets

Rapid damage to brake rotor will occur if pads wear to the point of rivets or backing plate touching rotor

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- **Brake balance control system**
- Brake warning lights
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Balance control system

- Engineered part of each system
- Not common service items
- Promotes more even braking

Balance control system

- Metering valve
- Proportioning valve
- Combination valve

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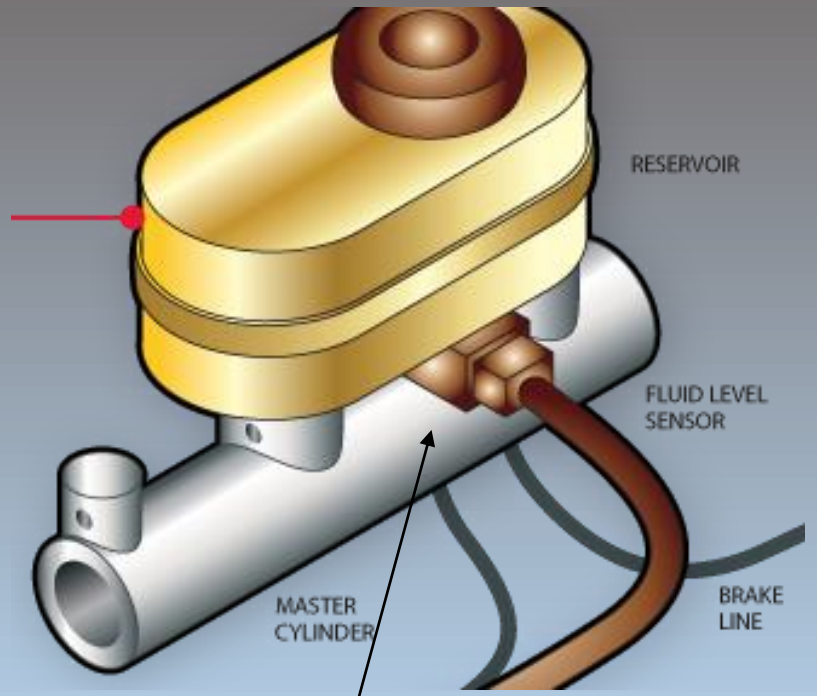
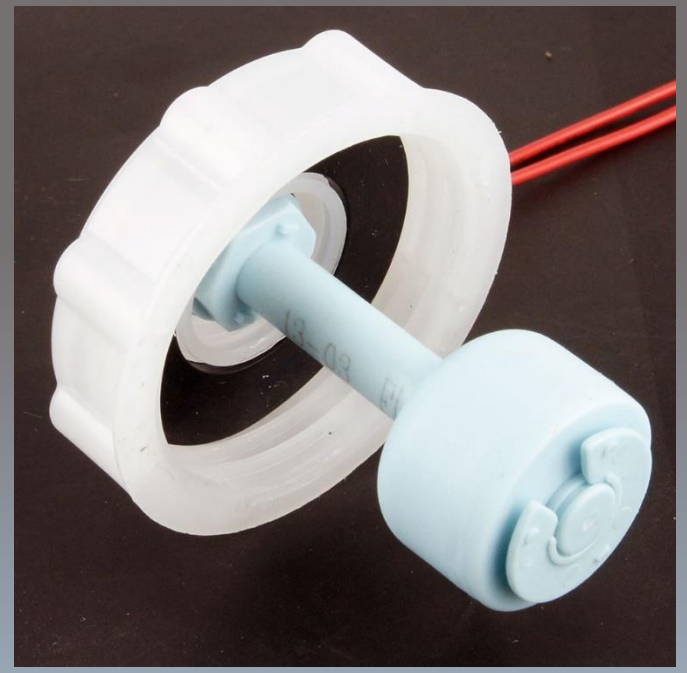
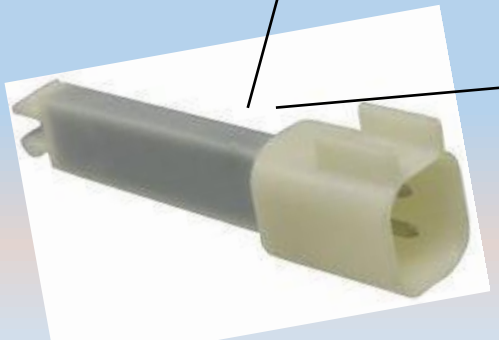
Brake warning lights

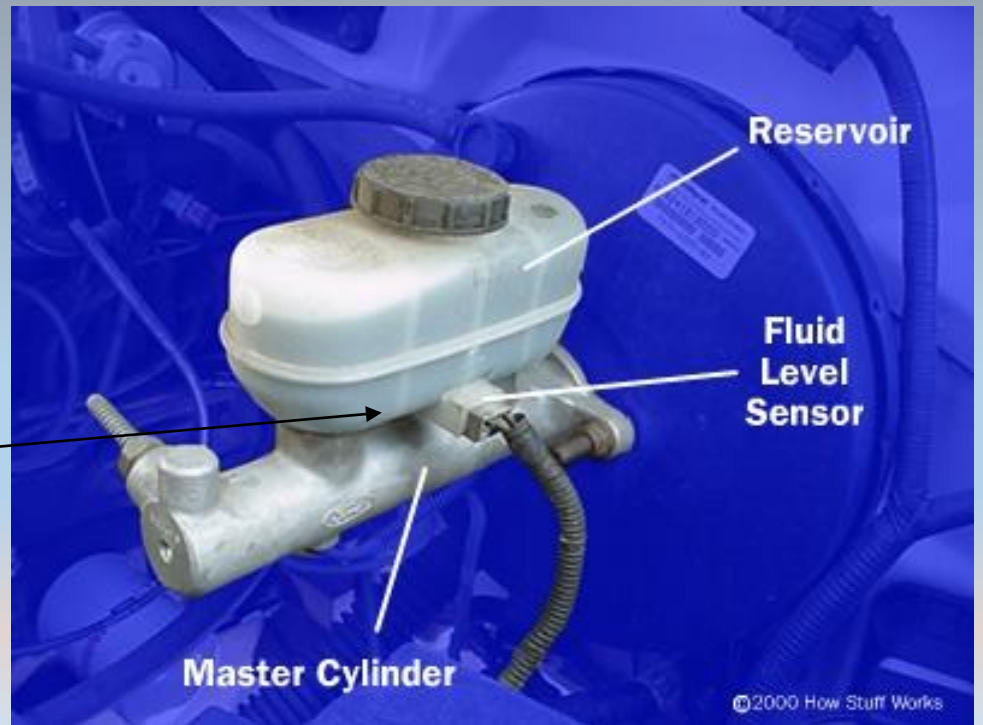
- How it works
  - Illuminates warning light on dash to alert driver
- Why it could come on
  - Difference in hydraulic split pressure
  - Low brake fluid in master cylinder reserve
  - Parking brake is applied
  - Problem detected in Anti-Lock brakes
    - Accompanied by a ABS light
  - Some models have electronic brake wear sensors

Master cylinder fluid level switch



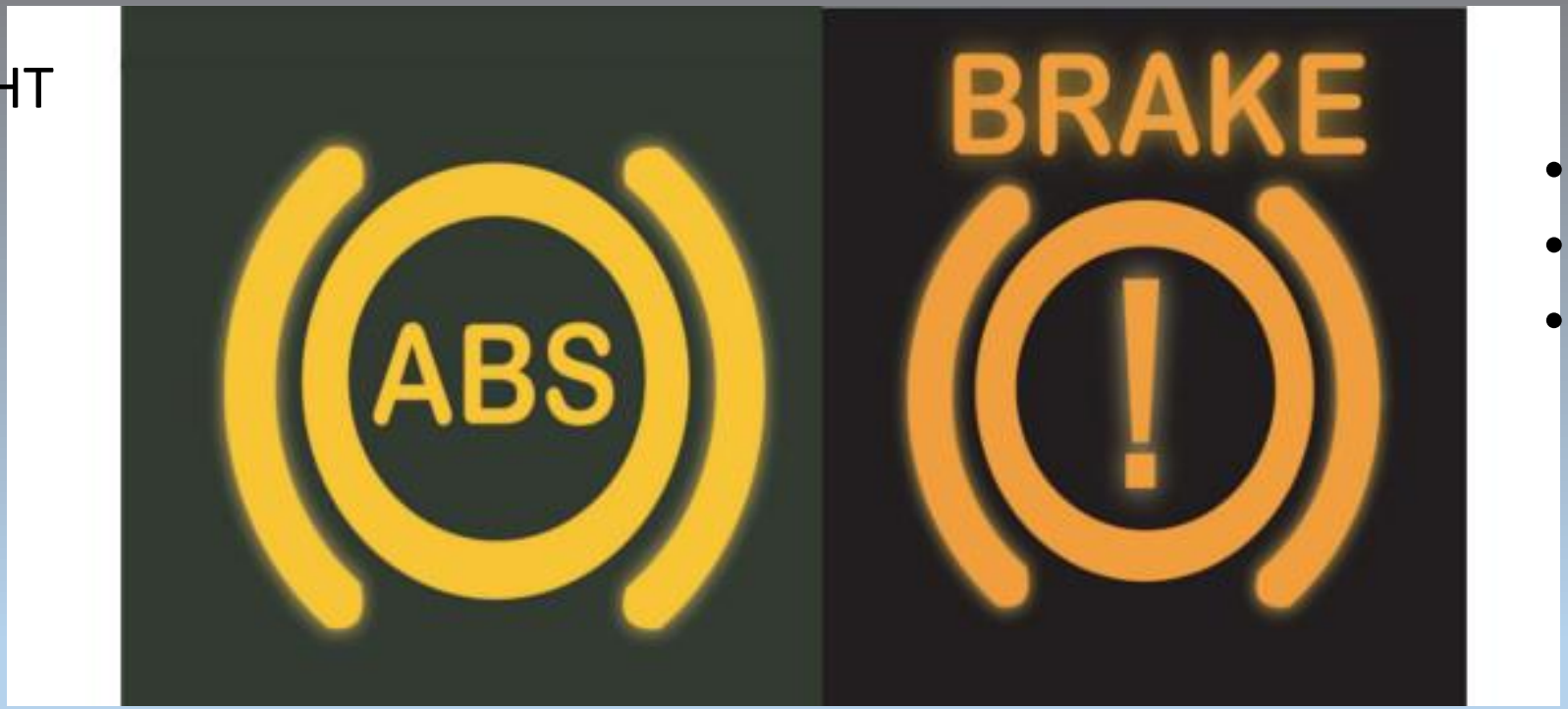






Brake warning lights

- YELLOW LIGHT
- CAUTION



- RED LIGHT
- SERIOUS PROBLEM
- STOP DRIVING

Categories of brake system

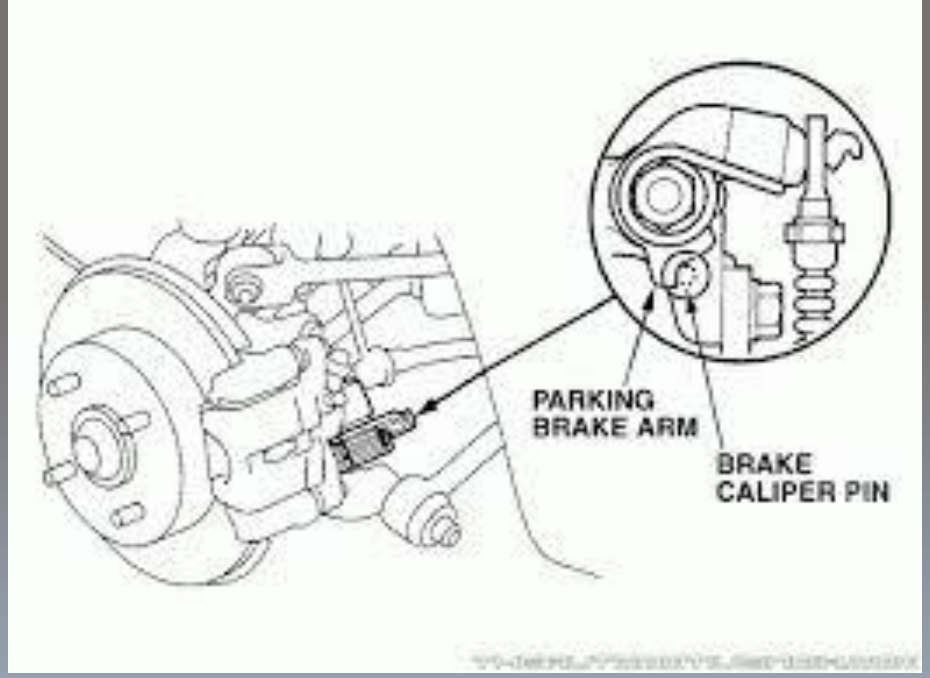
- Apply system
- Boost system
- Hydraulic system
- Wheel brakes
- Brake balance control system
- Brake warning lights
- **Parking brake**

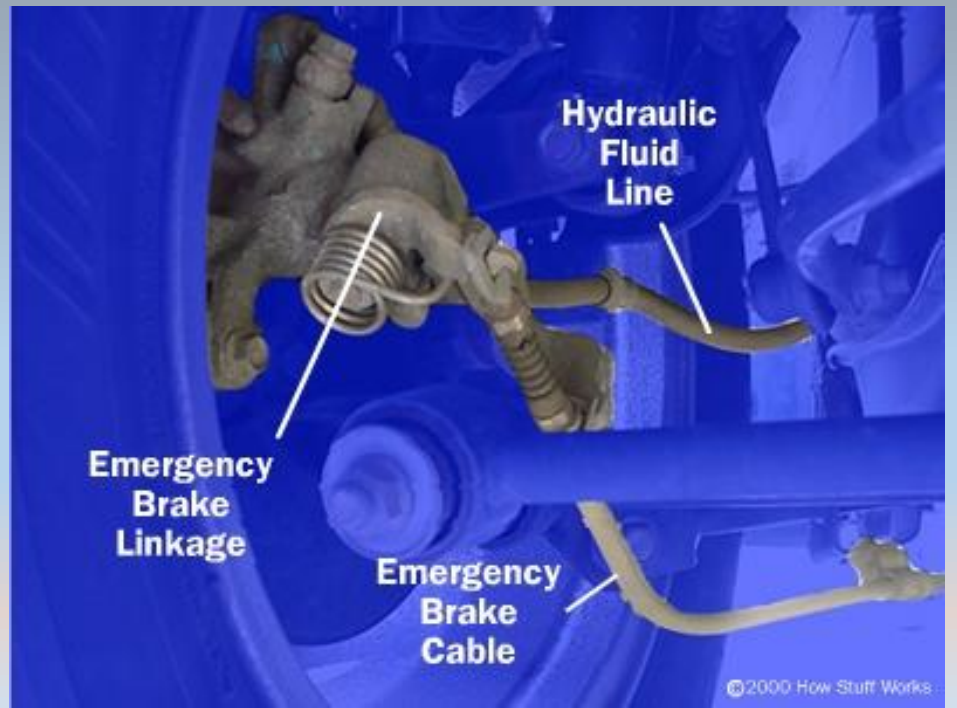
Parking brake

- Not called emergency brake anymore
- Most cable operated from separate pedal/hand lever
  - Some electrical motor to apply the park brake mechanism
- Ratcheting mechanism and release
- Difference in systems at wheels ***
- Service
  - Cable adjustment
  - Cable repair
    - Corrosion
    - Lack of use
      - Can cause cable to seize inside housing

Parking brake

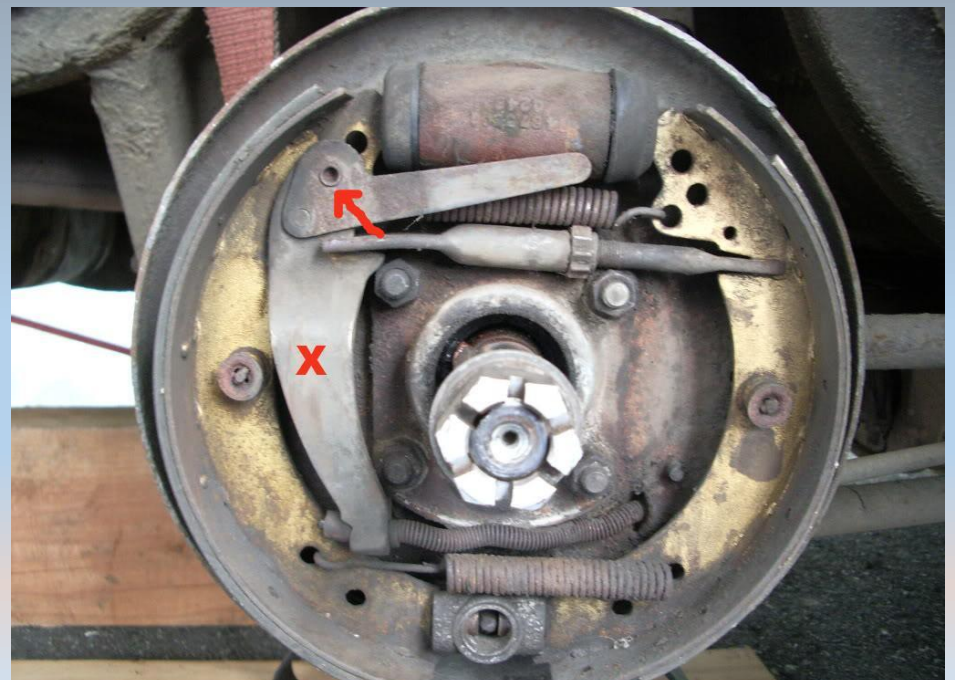
- Disc brakes
  - Requires special tools
  - More complex caliper
  - More potential for problems
  - More expensive to replace

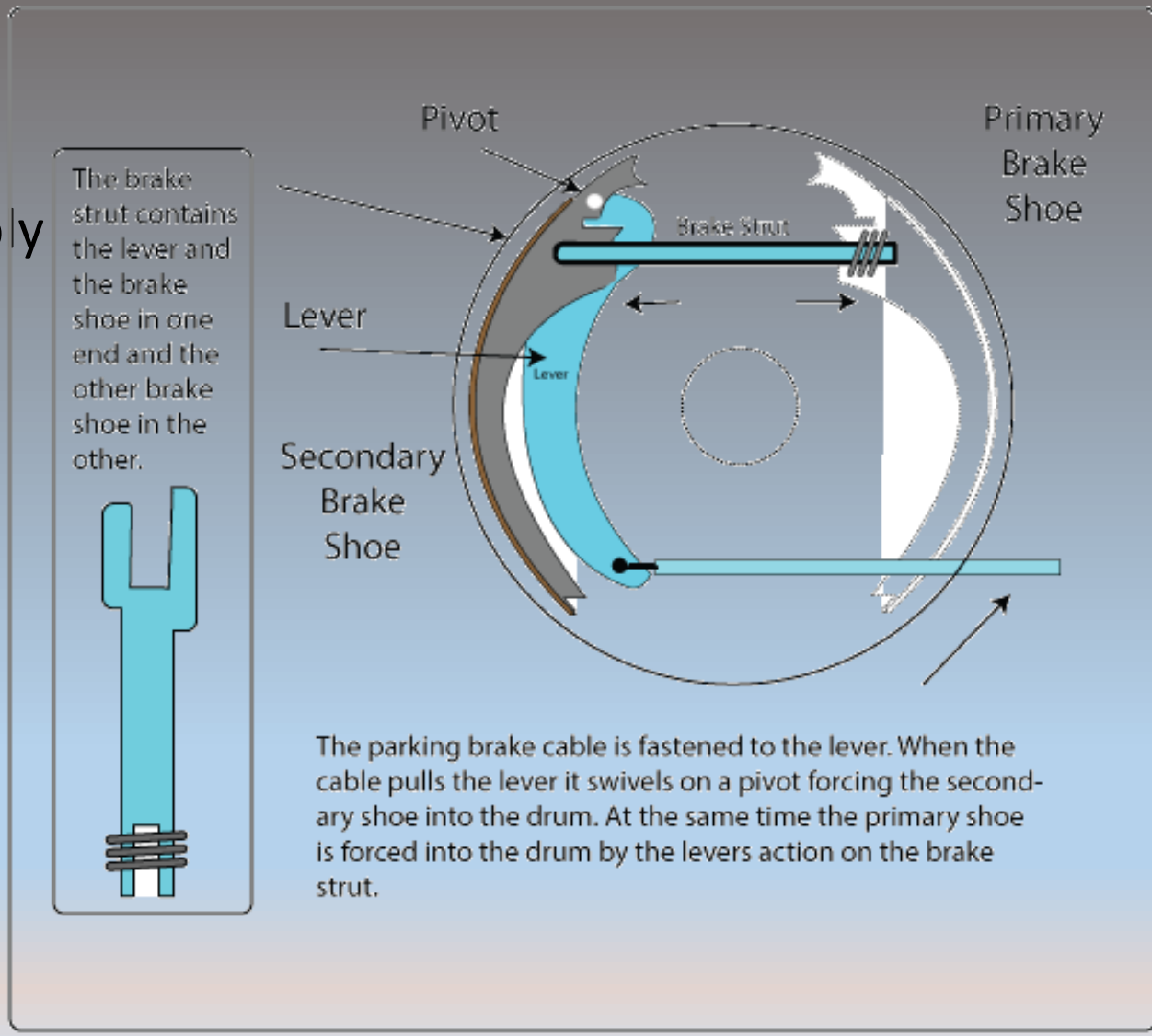




Parking brake

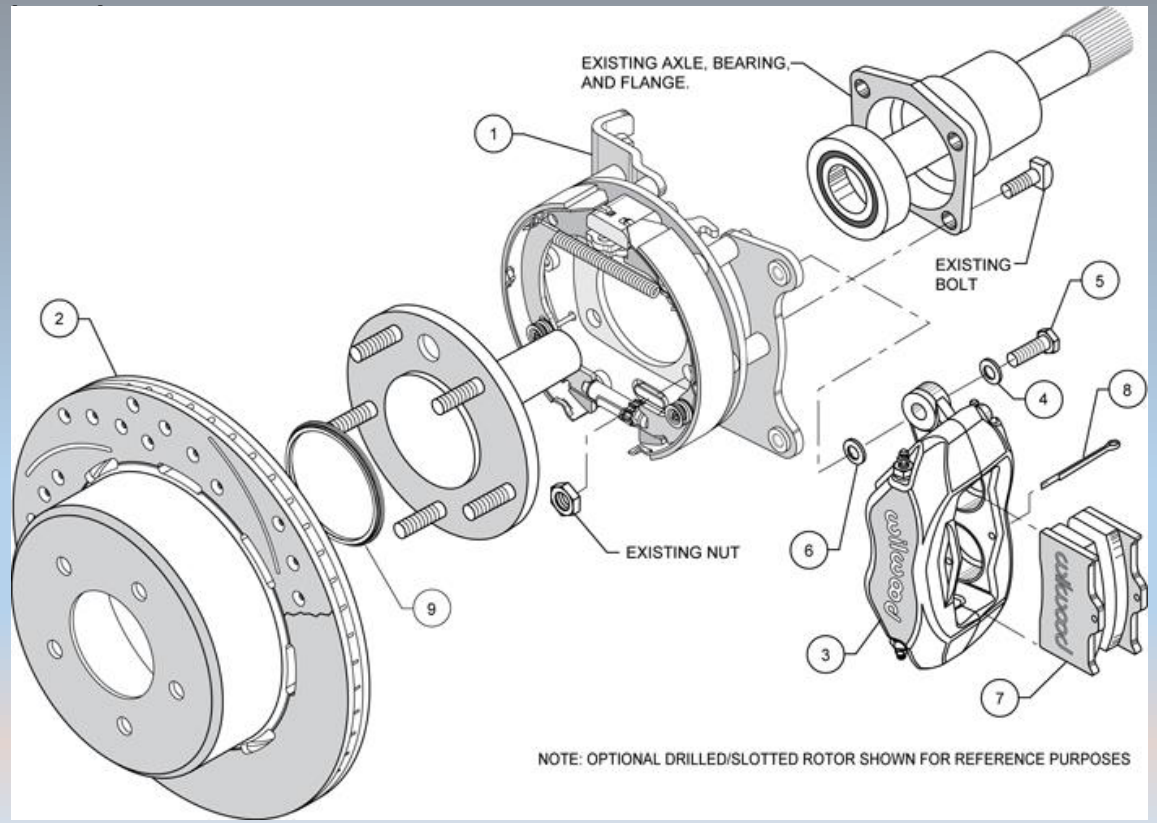
- Drum brakes
  - Cable pulls a lever inside drum to apply
  - Fairly simple
  - Needs adjustment





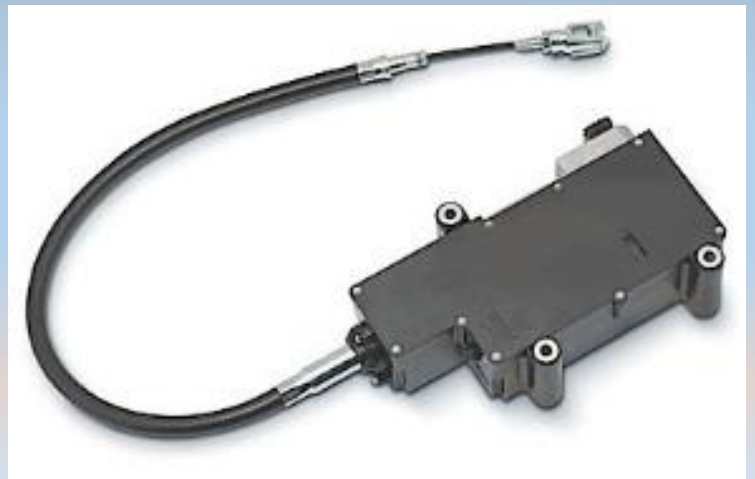
Parking brake

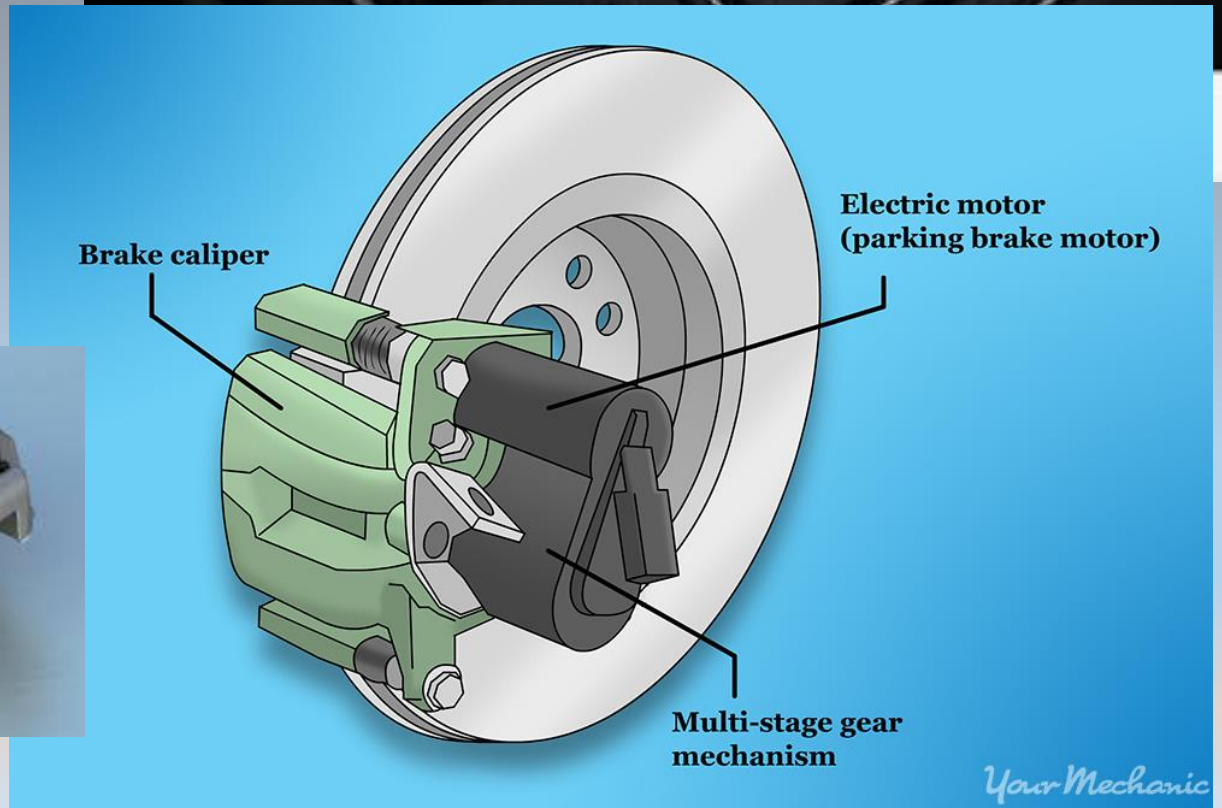
- Disc / drum HAT STYLE
  - DRUM parking brake inside of rotor HAT
  - Work separate of each other
  - Common on trucks with 4 wheel disc



Parking brake

- Electric
  - Common on hybrid and European
  - Needs scan tool to actuate & reset
  - Hybrids test at start-up
  - Push button operation
  - Computer can apply when put in park



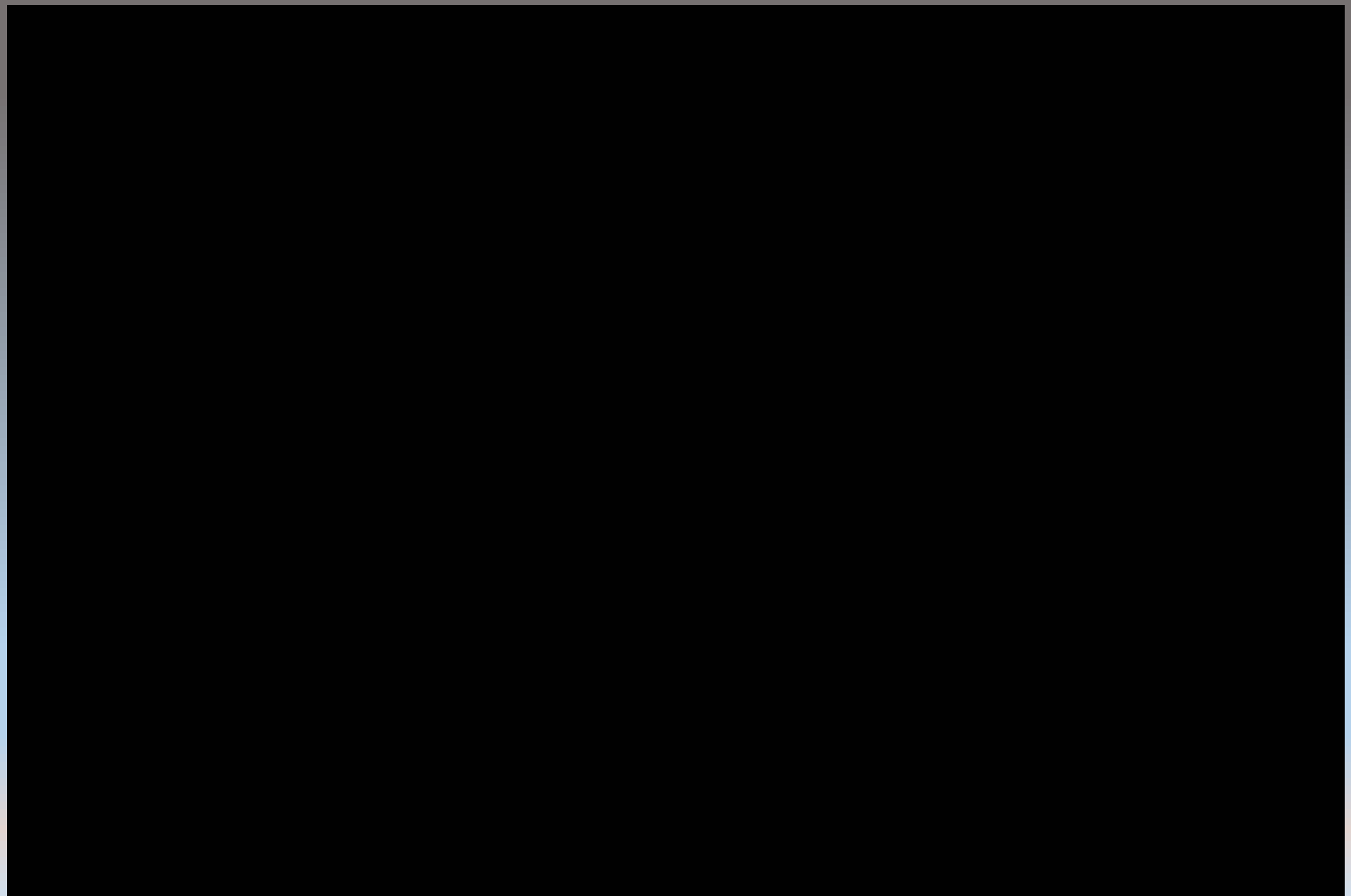


Anti Lock Brakes

- Prevents wheel lock-up (skidding) during braking event
  - Decreased stopping distance
  - Ability to steer during extreme braking

- How?
  - Computer takes control of hydraulic pressure and modulates to the wheel brakes to keep from skidding
  - Additional computer controlled hydraulic valving
  - Uses wheel speed and other inputs for computers strategy

Anti Lock Brakes reasoning



Questions ????

GSA Steering / Suspension SYSTEM TRAINING

Kent Meckfessel

SIUC

Automotive Technology

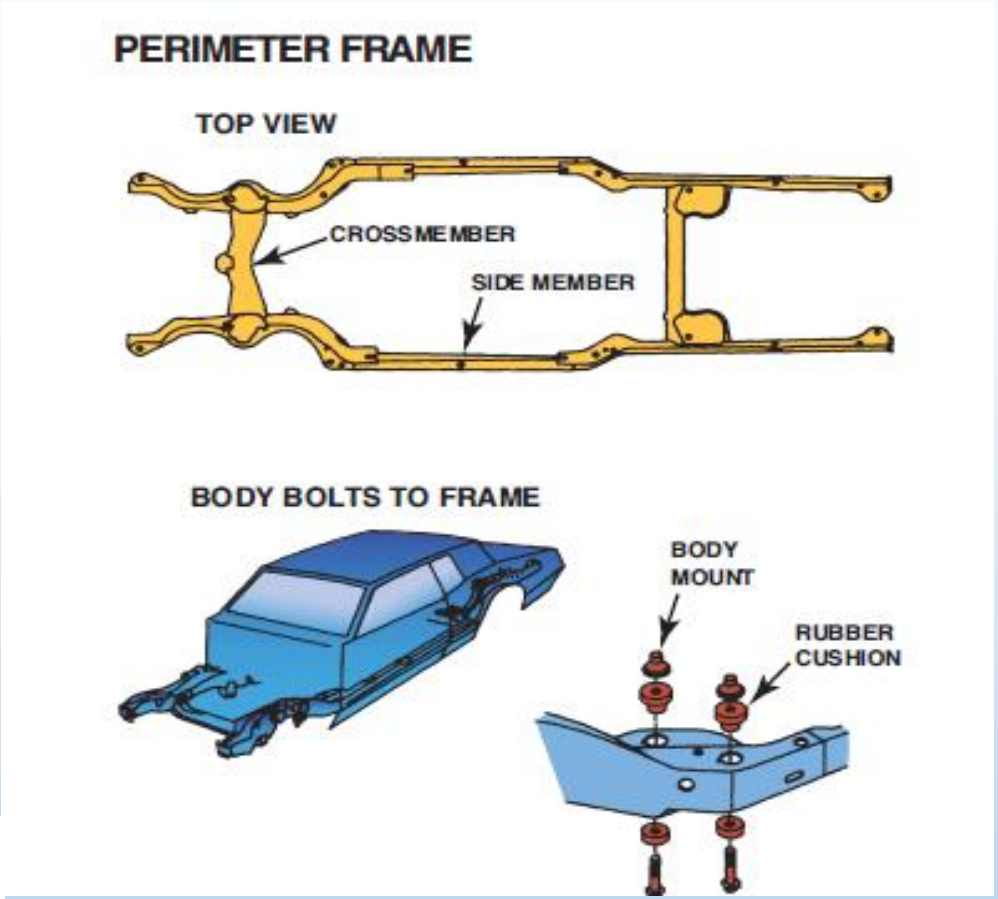
Kmeckfessel@siu.edu

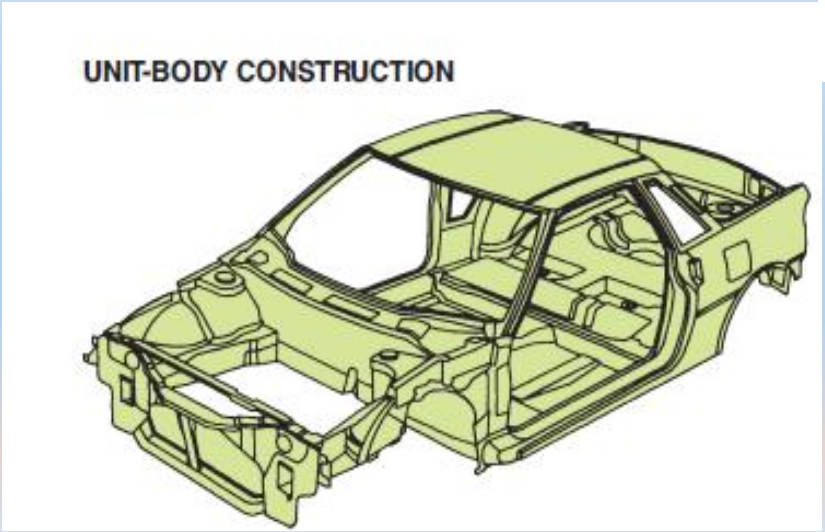
Suspension system

- Frame Construction
- Springs
- Shocks/struts
- Independent vs solid
- Components
  - Knuckle
  - Ball joints
  - Control arms
  - Sway bar
  - Strut
  - Wheel bearings

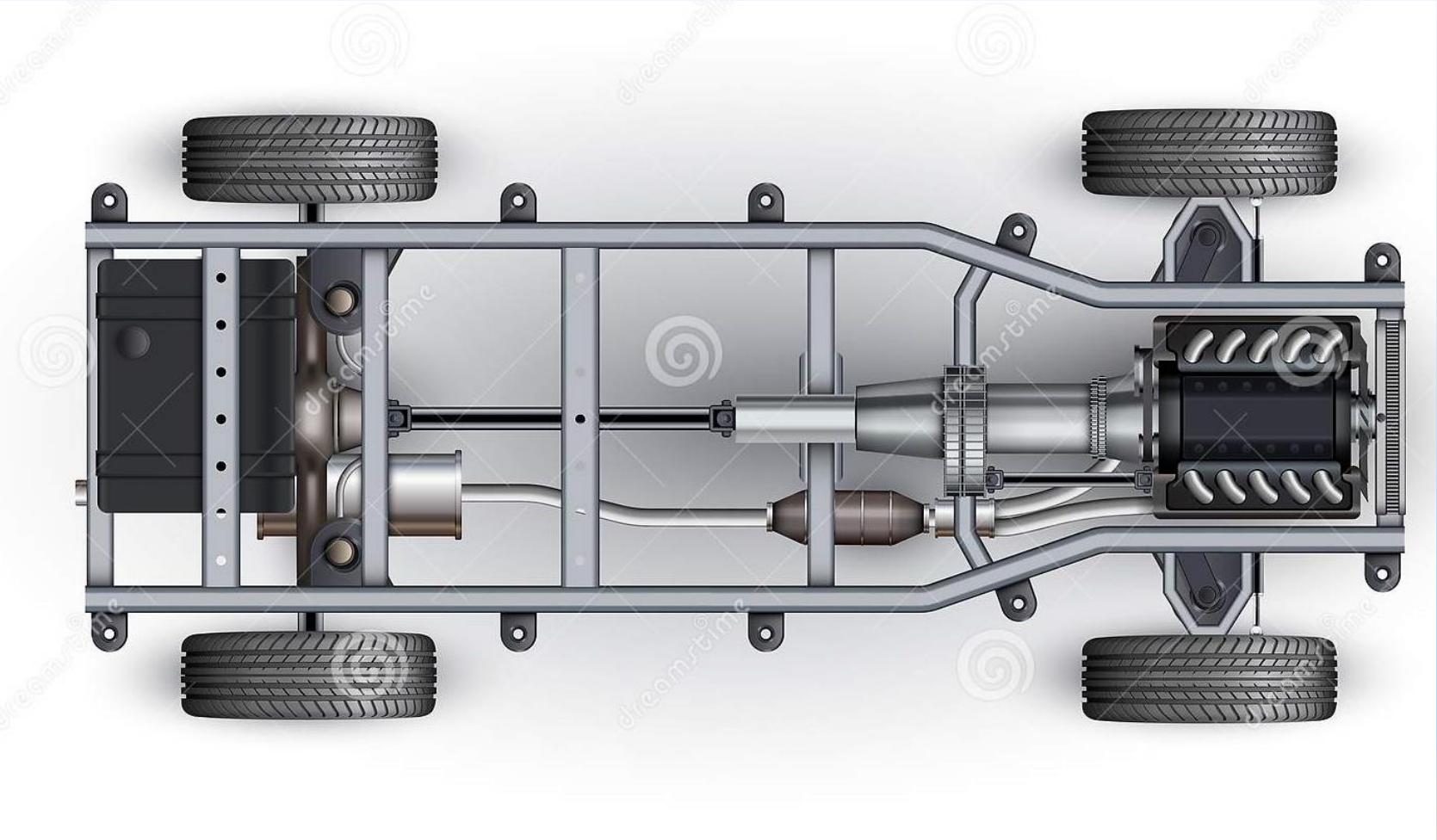
Frame Construction

- channel-shaped steel beams welded and/or fastened together.
- FULL FRAME
- SUB FRAME
  - Uni-body

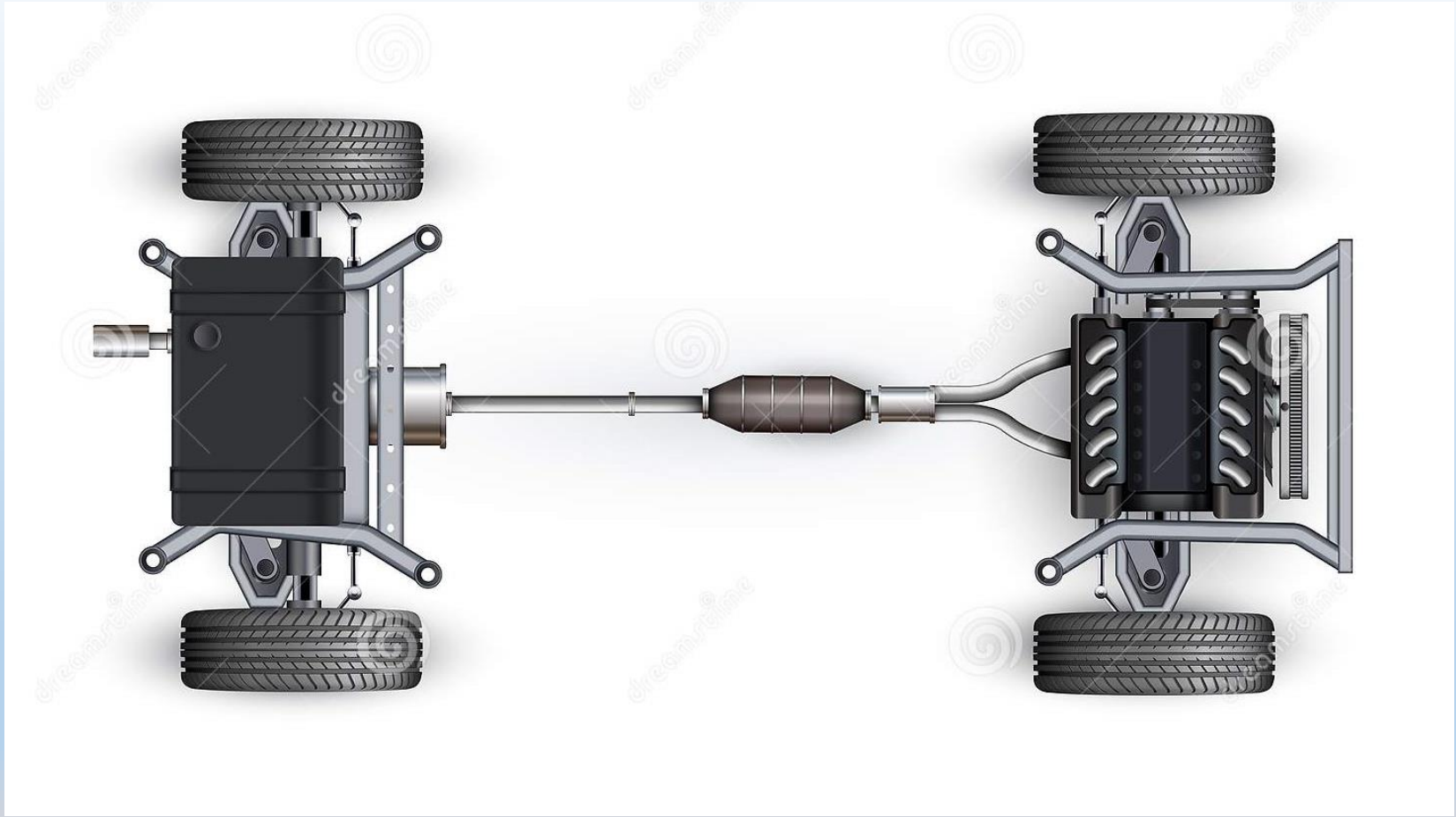




Full frame construction

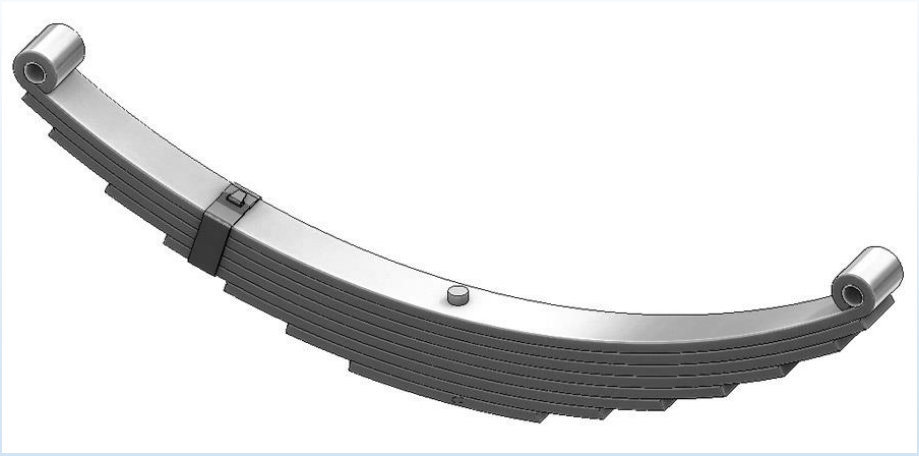


Sub frame and Uni-body construction



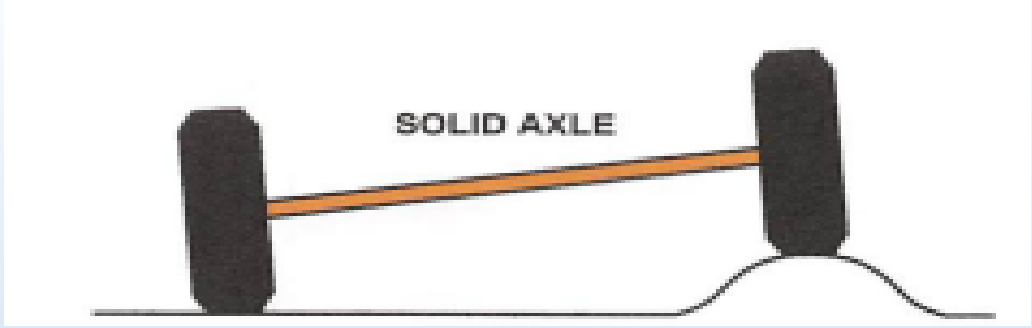
Springs

- Coil
  - Compressing
- Leaf
  - flattening motion
- Torsion bar
  - twisting motion
- Air bag
  - Squishing
  - Like a balloon

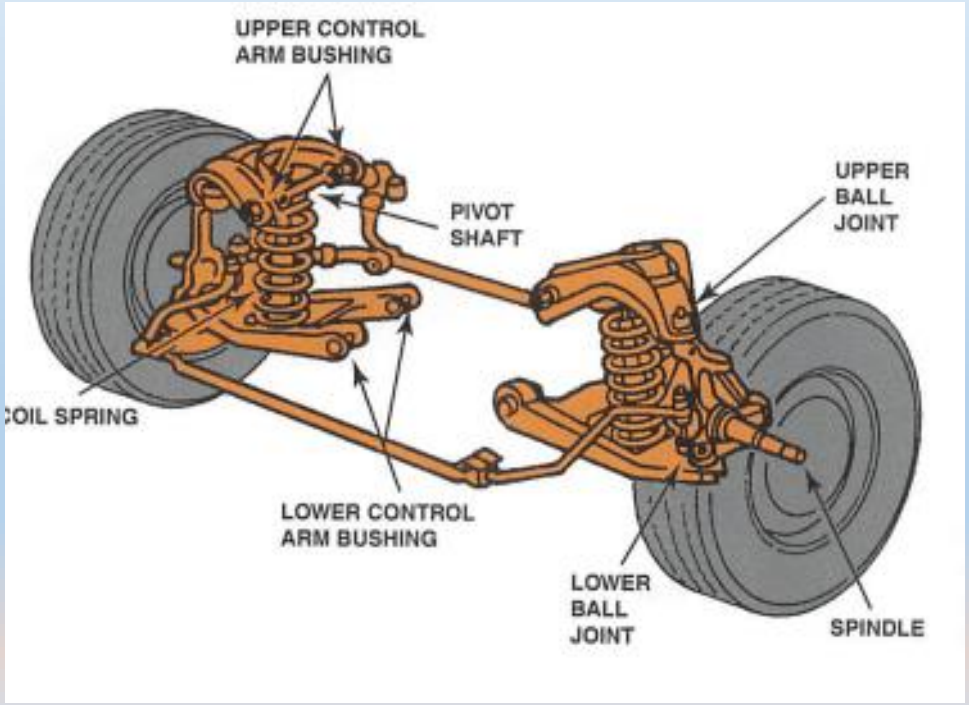


Basic Types of Suspensions

- Solid axle
  - One wheel affects the other



- Independent
  - Separate moving components
    - Control arms
    - Struts

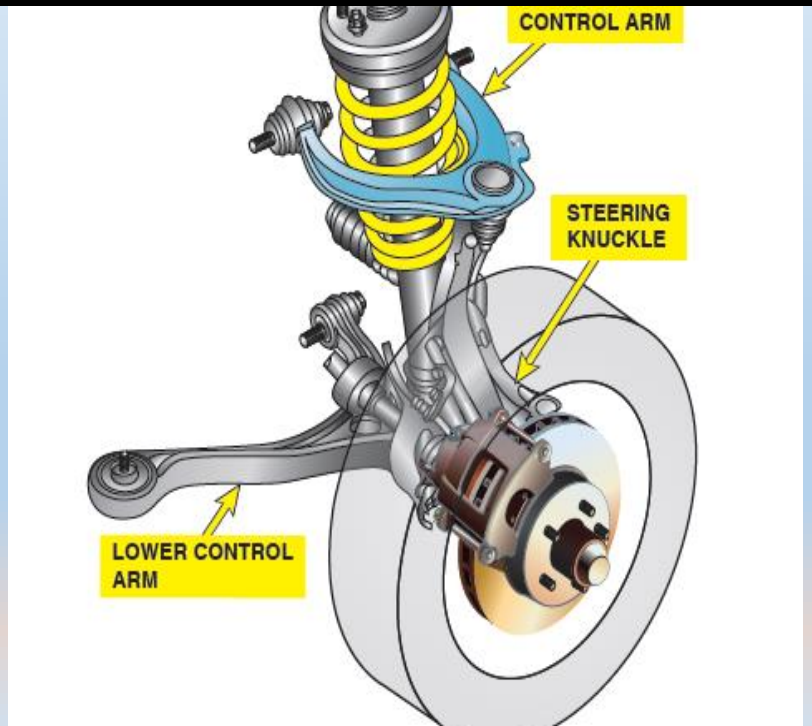


Un-sprung weight

- The lighter the wheel/tire combination, the lower the unsprung weight and the better the ride and handling of the vehicle.
- Includes
  - Tire/wheel
  - Suspension/steering
  - Brakes
  - Wheel bearing/hub

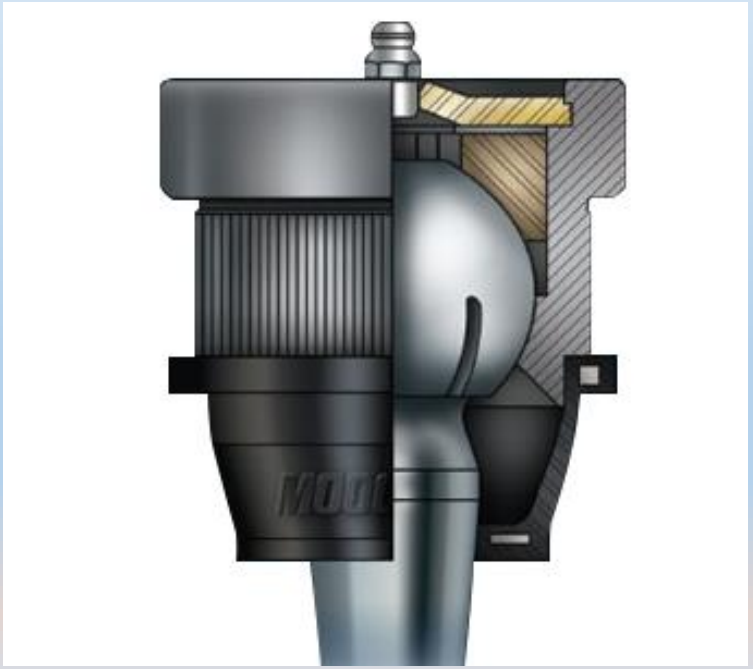
Steering Knuckle

- To join the suspension to the wheel
- Usually includes the spindle where the front wheel bearings are attached
- To provide pivot for steering movement
- To provide pivot points for the suspension travel



Ball Joints

- Ball joints attach to control arms to the knuckle
- Ball / socket linkage
- Support Up & down suspension
- Support the turning motion



Control Arms

- Suspension link that connects a knuckle to the frame.
- Allows for suspension up & down travel
- Bushings and ball joint to wear

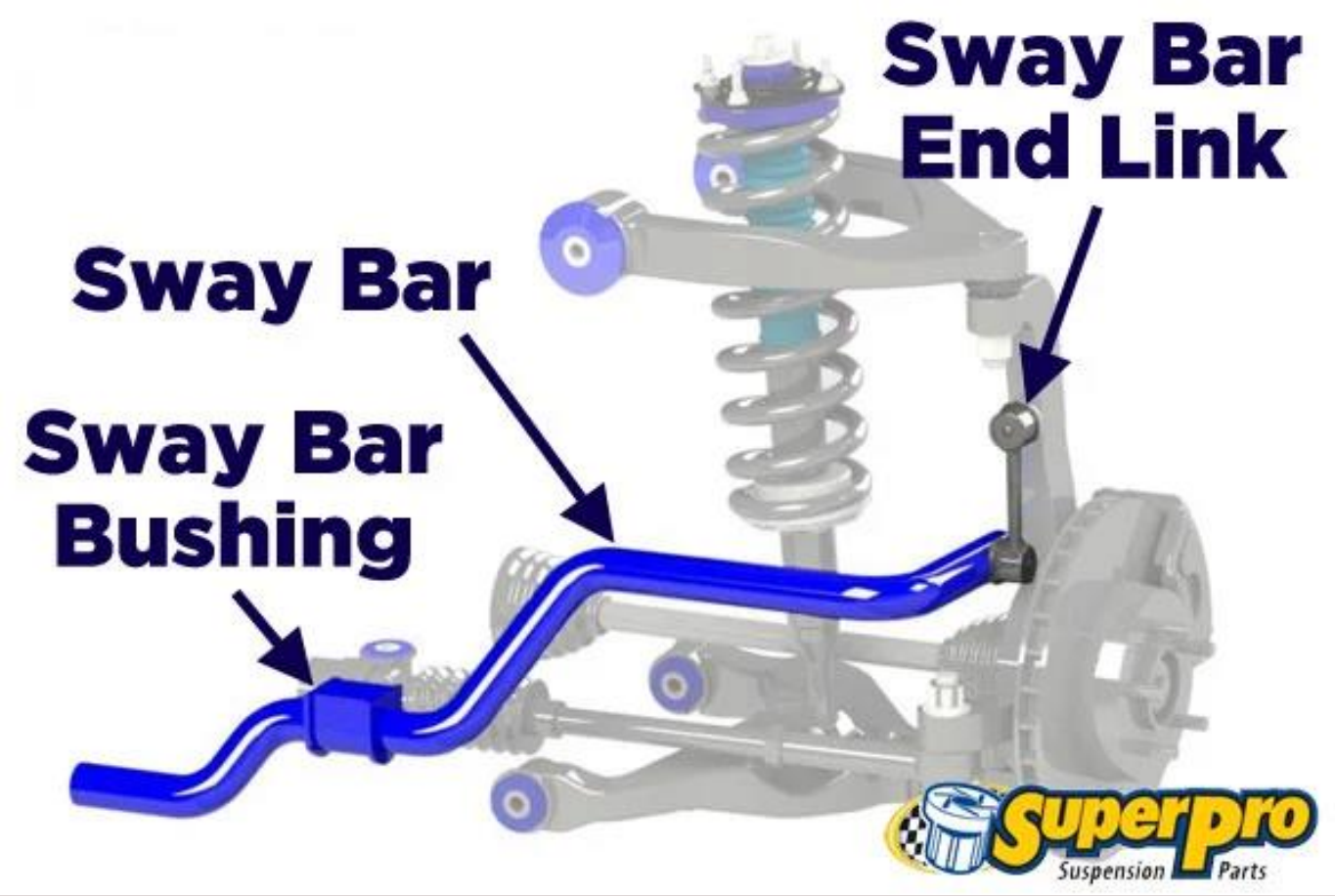
Shock Absorber

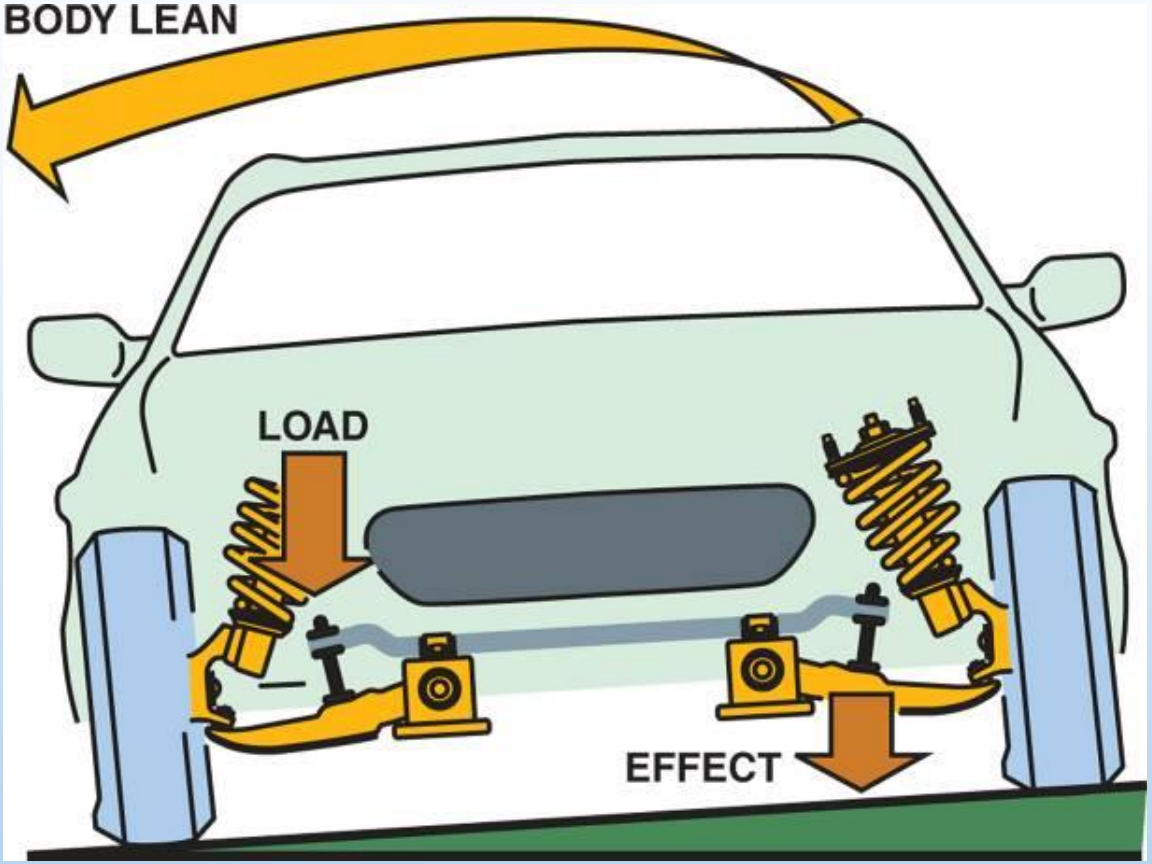
- Dampen and control the motion of the vehicle’s springs.
- operates on the principle of fluid being forced through a small opening
- Pressurizing the oil inside the shock absorber helps smooth the ride over rough roads.
- Reducing the jounce and rebound helps control ride and handling.

Struts

- A strut is a sturdy shock absorber that is also a structural component of the suspension.
  - A strut is a suspension link as well as a shock absorber.

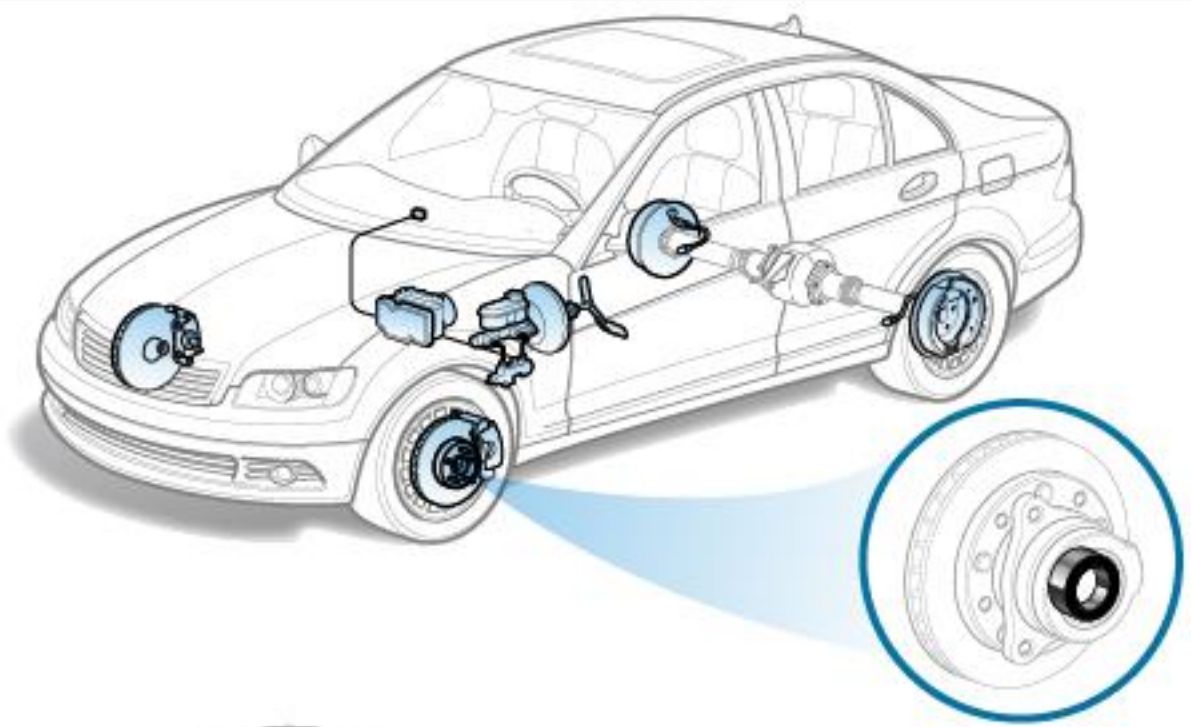
Stabilizer, Anti-Sway bar





As the body of the vehicle leans, the stabilizer bar is twisted. The force exerted by the stabilizer bar counteracts the body lean.

Wheel Bearings



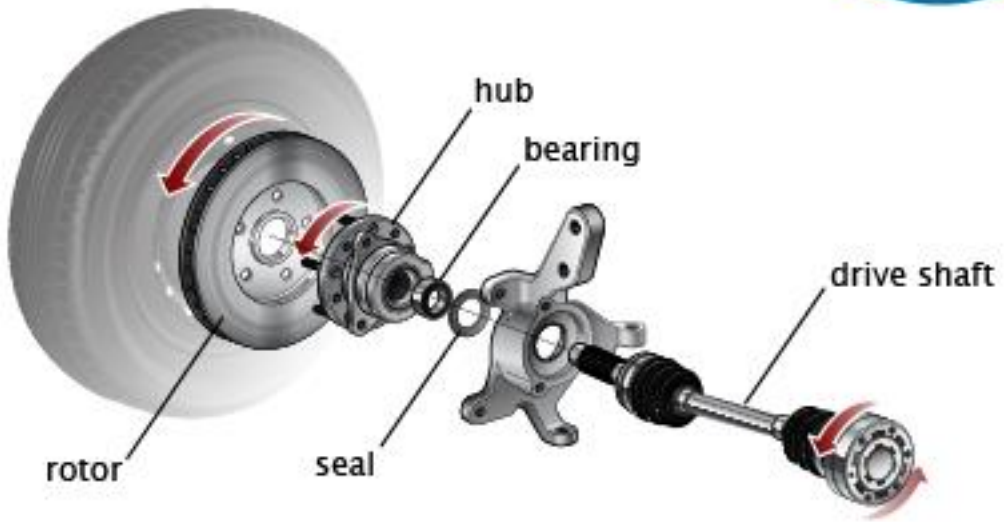


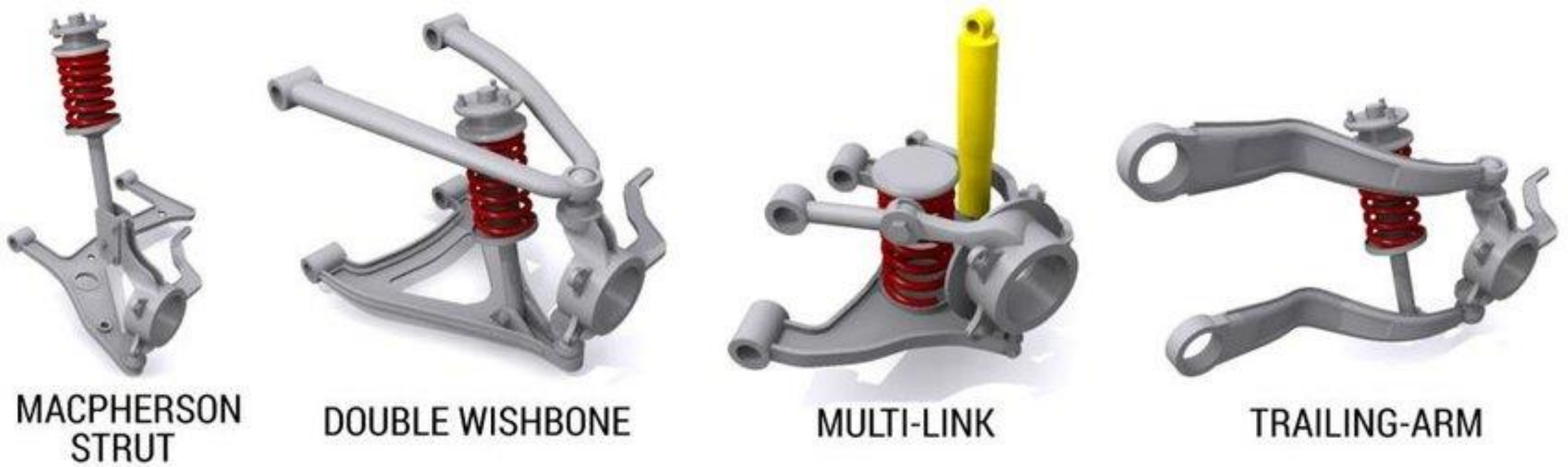
Image courtesy of ClearMechanic.com

Hub and bearing assembly

Wheel bearings

Hub and bearing
separate pieces

What is your suspension setup?
Many different variations, same parts

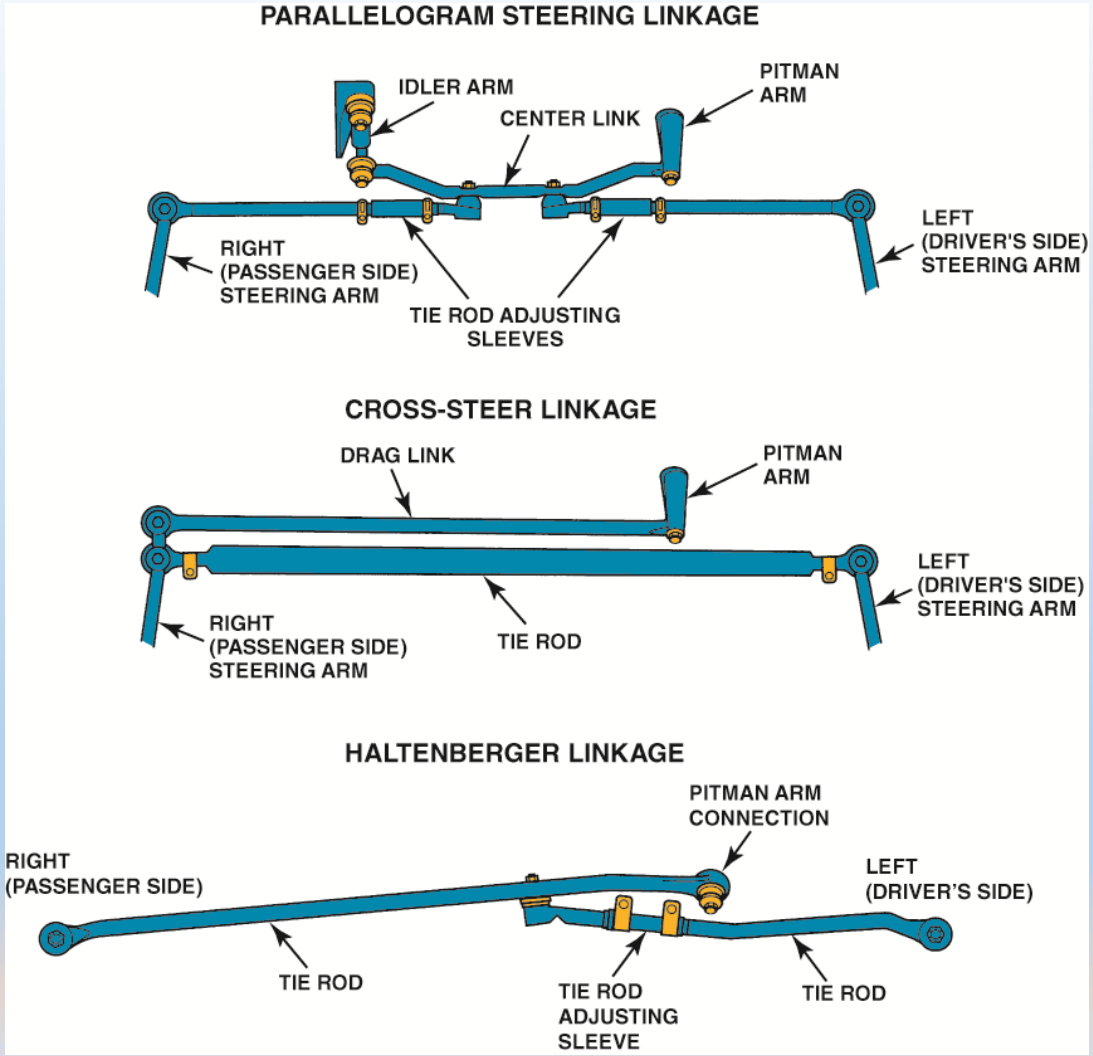


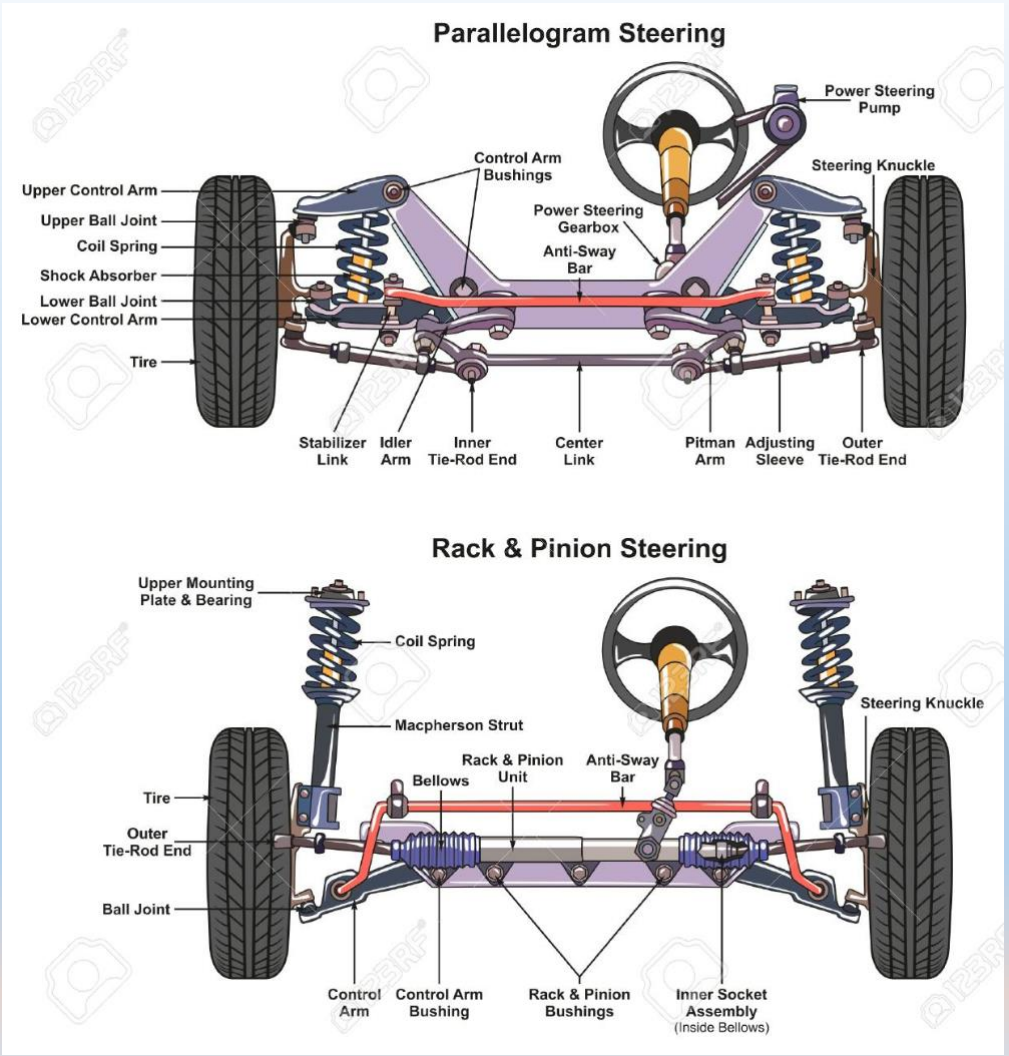
Questions ????

Steering system

- Types of linkage
- Integral to suspension type
- Components
  - Steering column
  - Steering Gear
  - Rack and pinion
  - Linkages
    - Tie rods
    - Center links
    - Idler/pitman
    - Rack gear

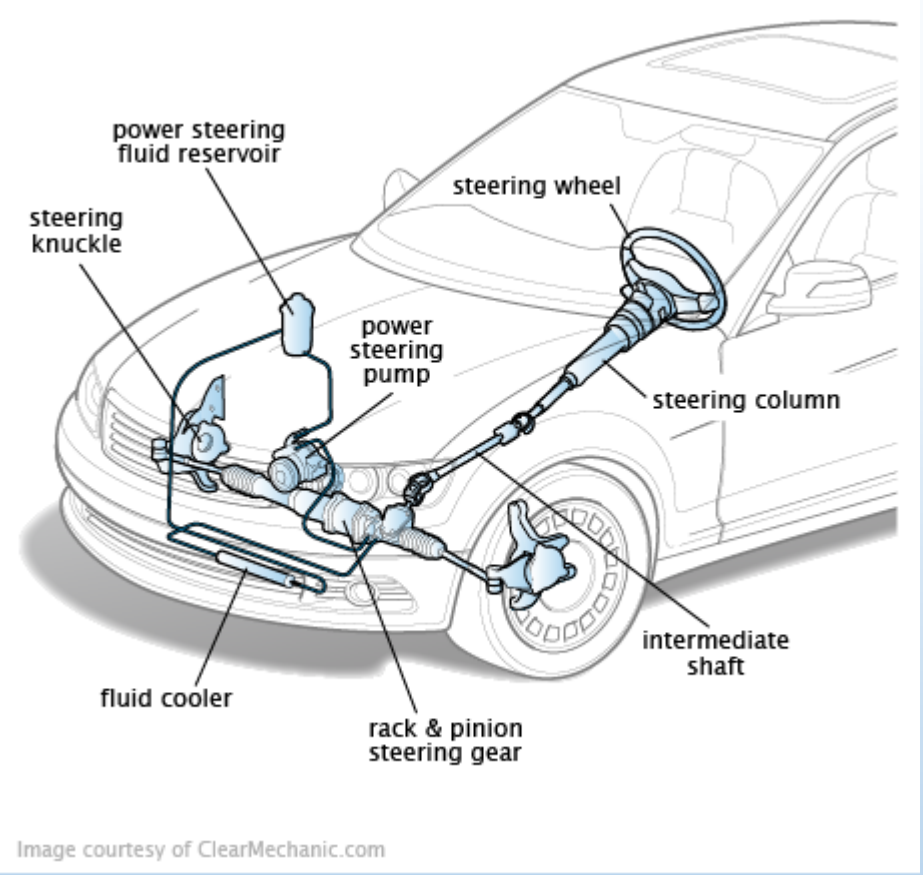
Types of linkages



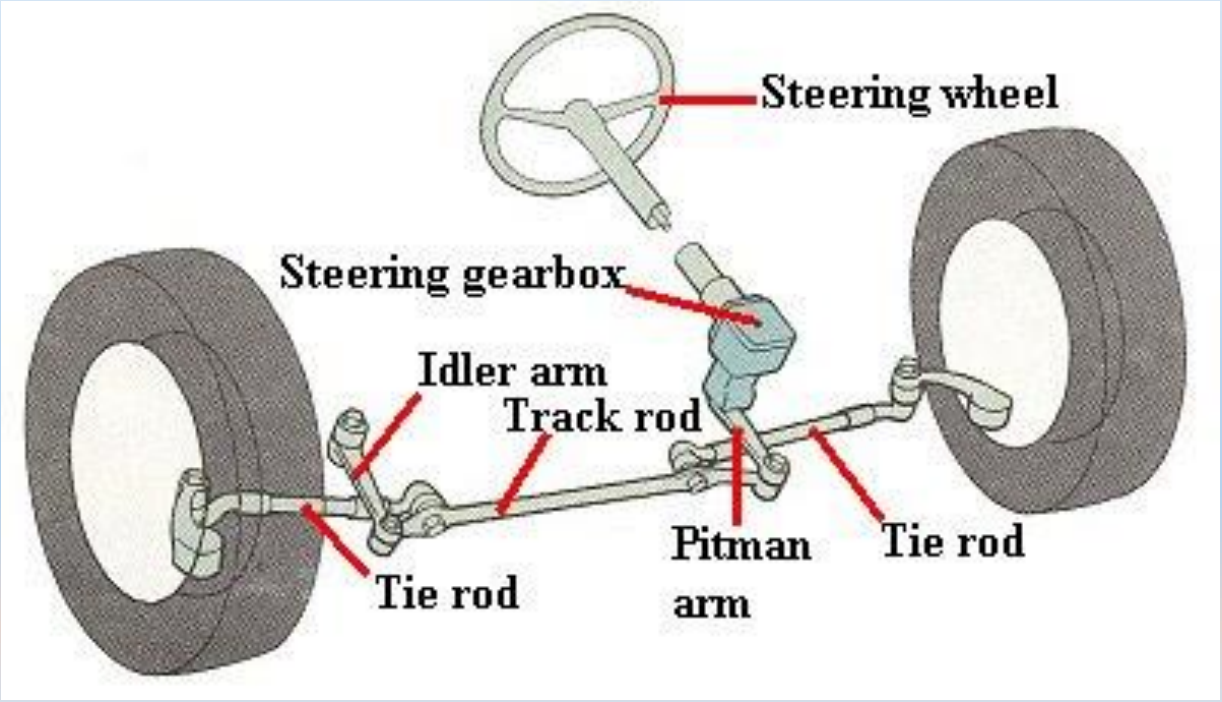


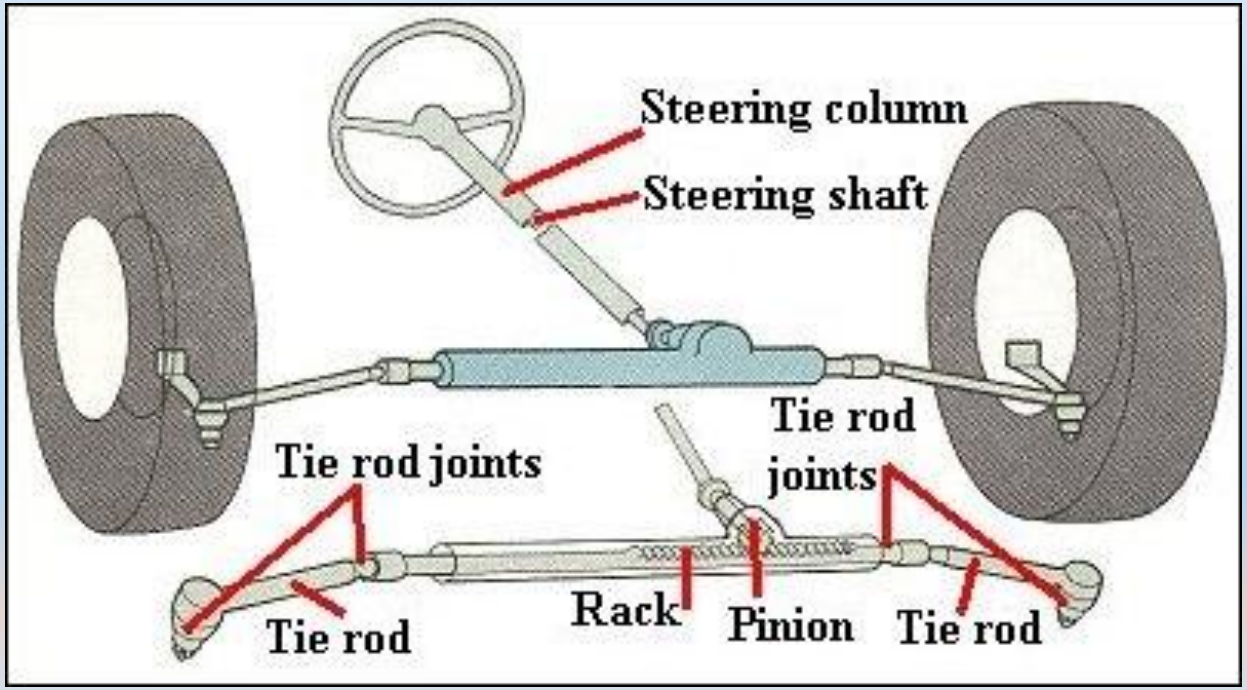
Steering Column

- Collapsible
- U-joints
- Airbag
- Steering angle sensor

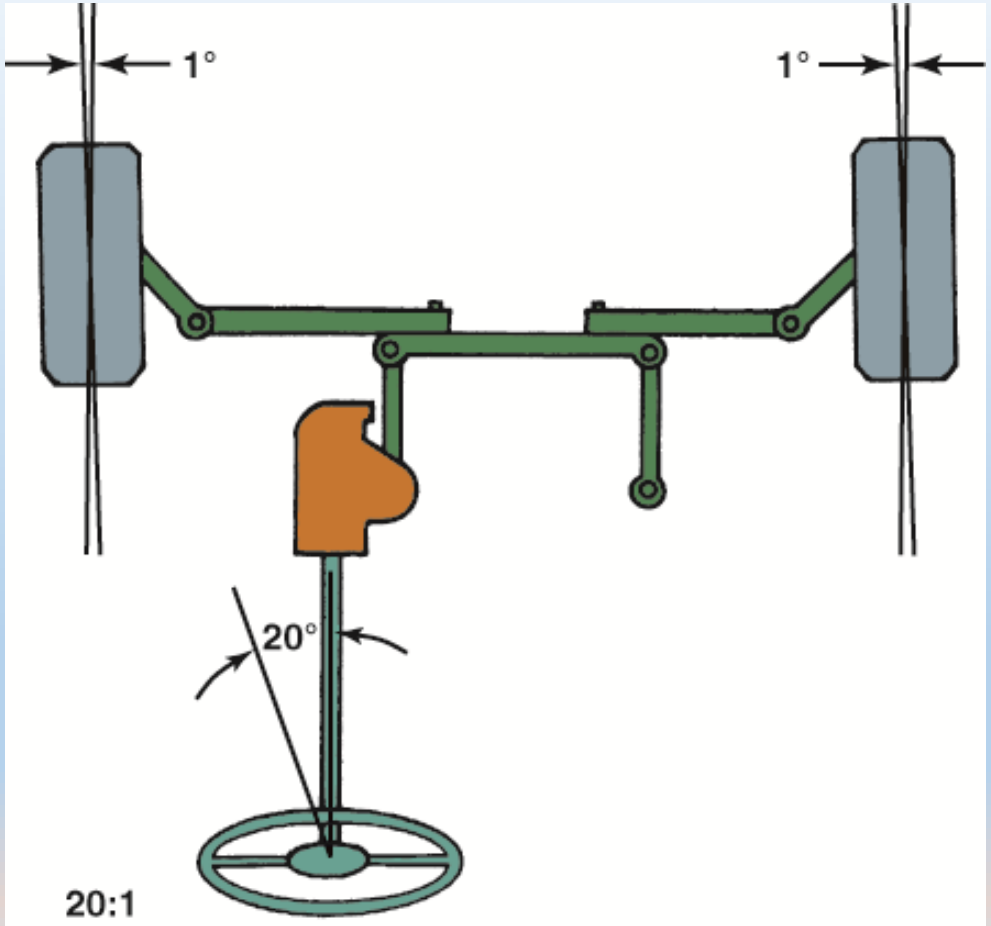


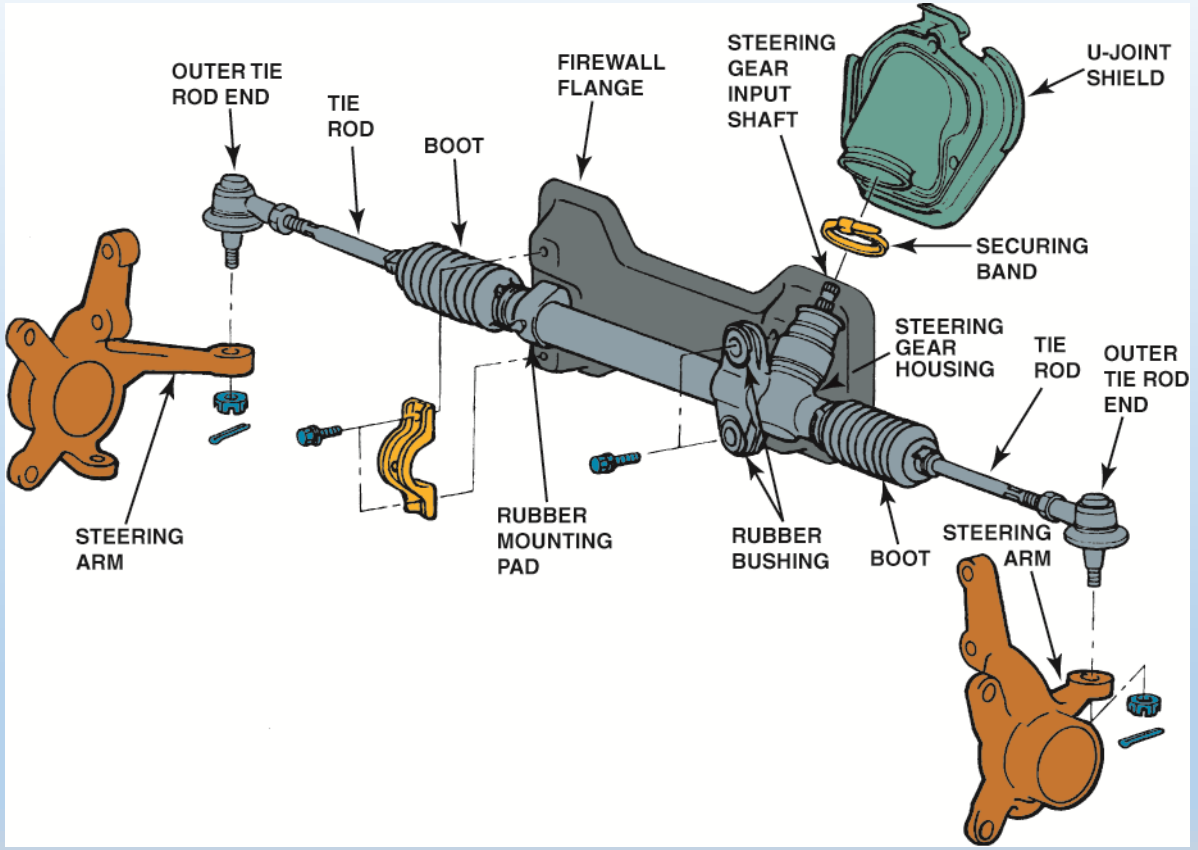
Steering column to steering gear



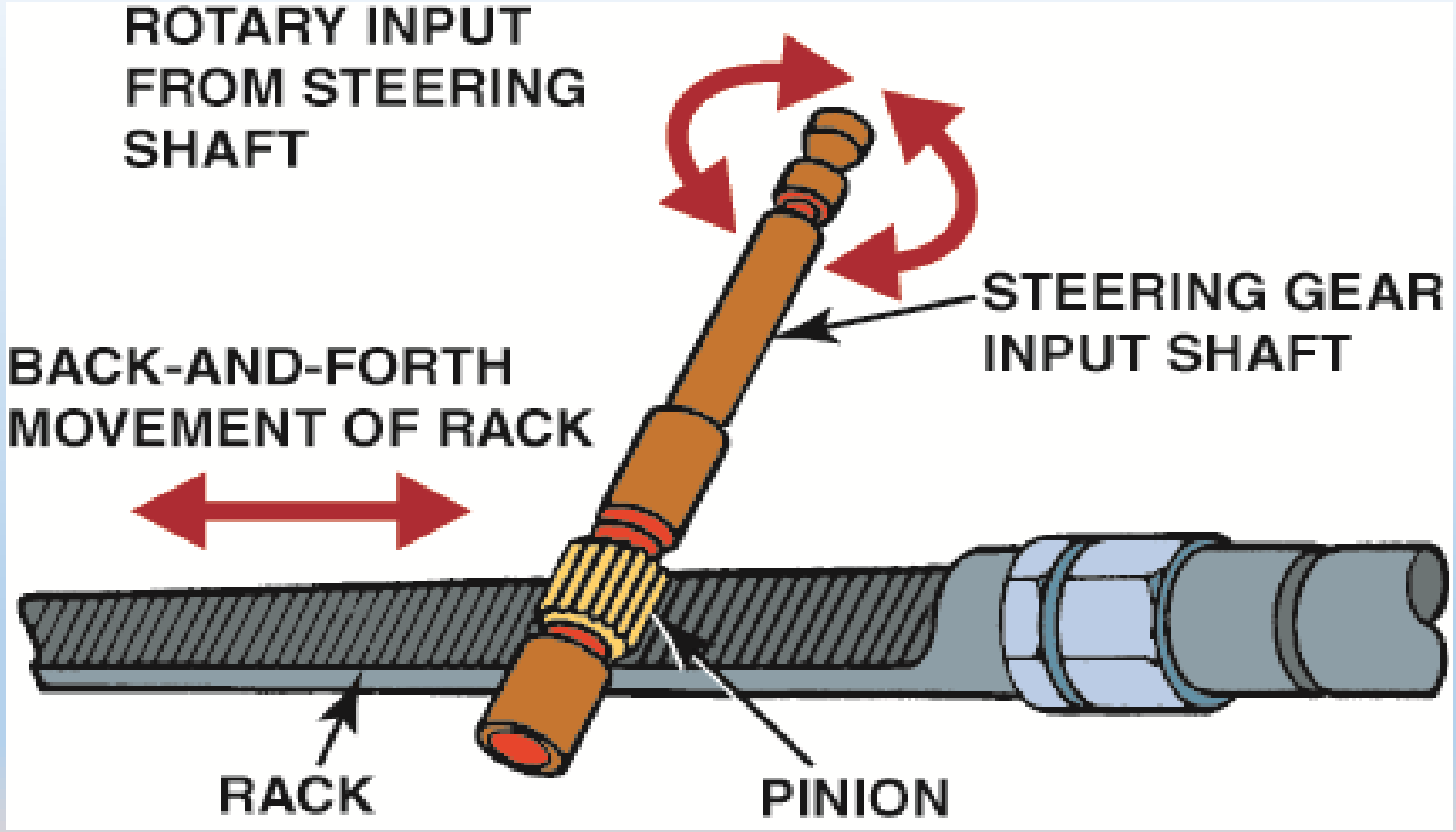


Steering gear



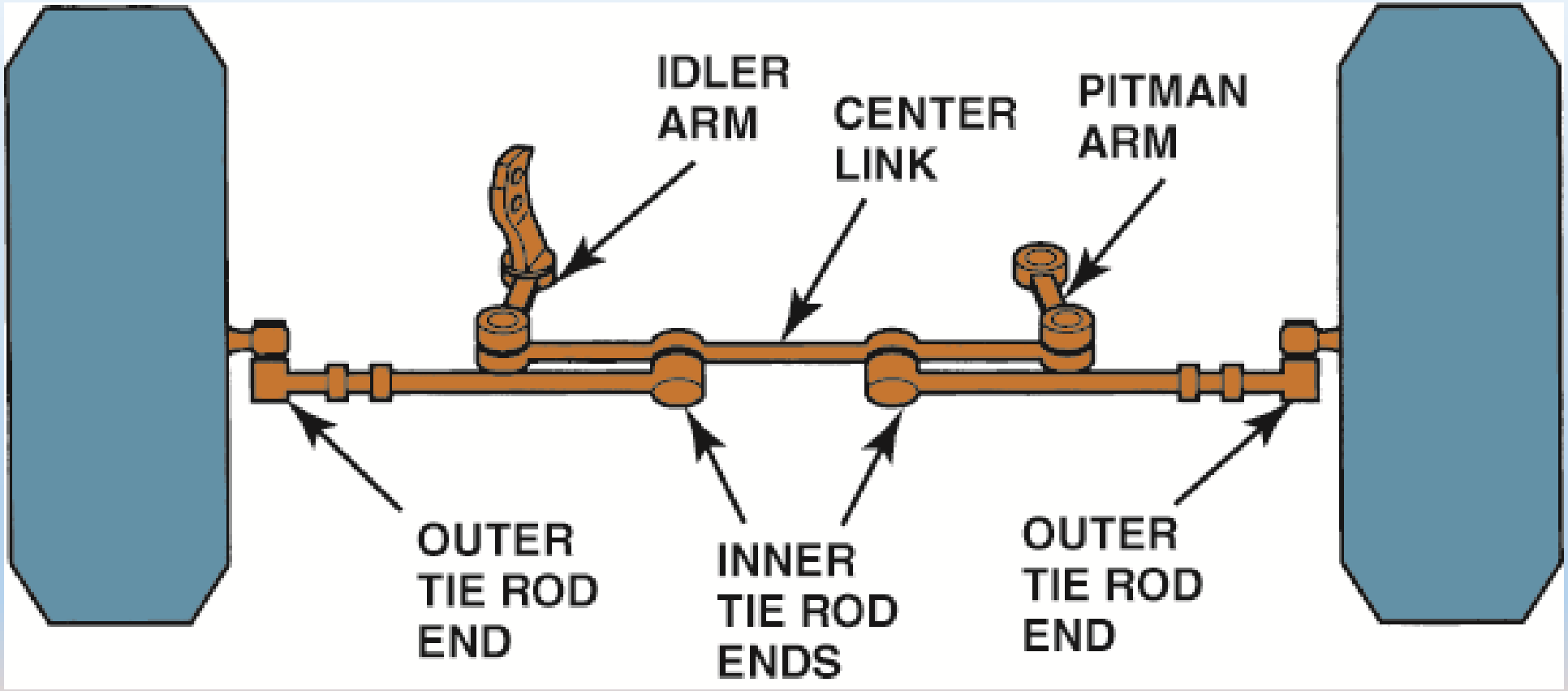


Rack and Pinion steering



Inner tie rods & bellows boot

Inner tie rods & bellows boot


IDLER ARM
CENTER LINK
PITMAN ARM
OUTER TIE ROD END
INNER TIE ROD ENDS
OUTER TIE ROD END

Questions ????

Steering/Suspension Service

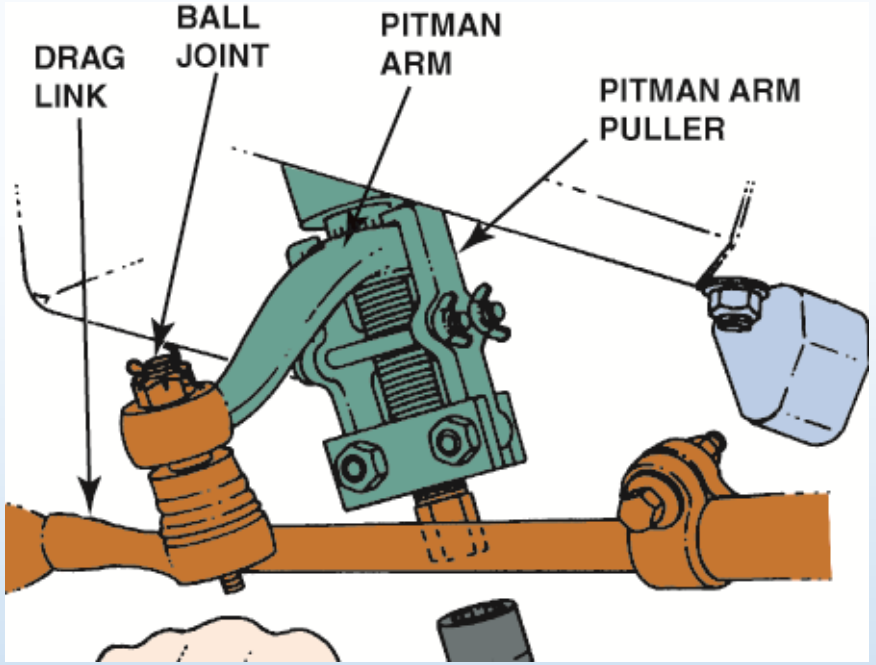
When

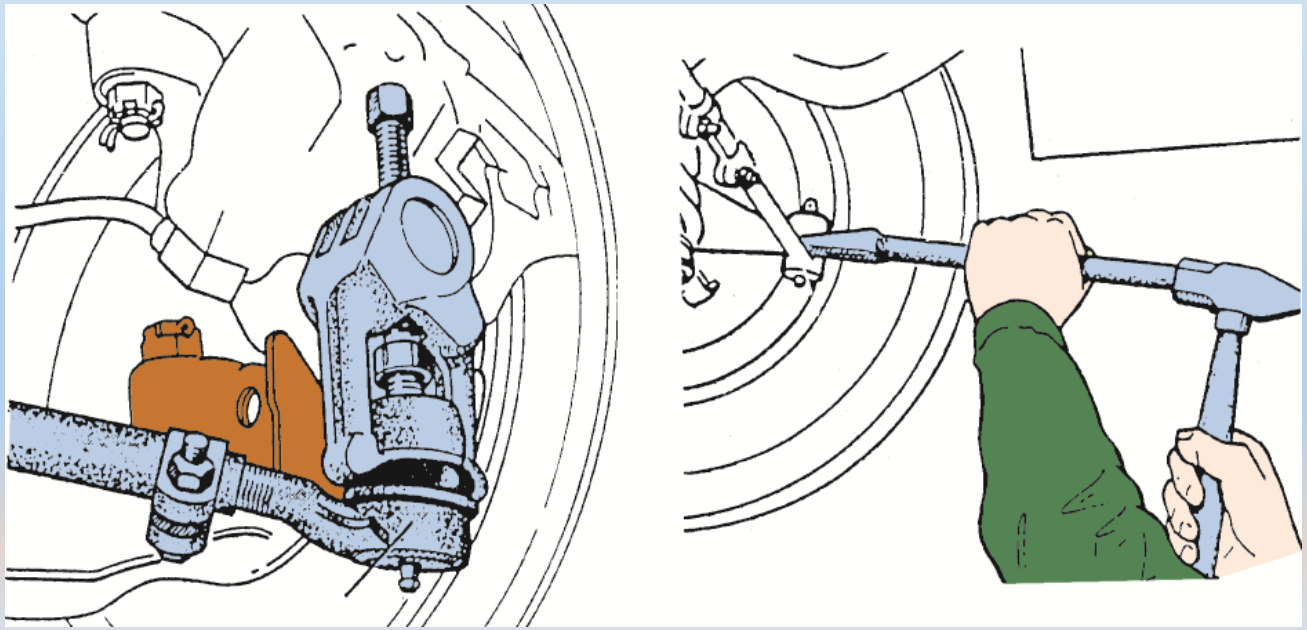
- Symptoms
  - Noise
  - Returnability
  - Steering off-center
- Loose connections (play in ball & sockets)
- Poor handling
- Tire wear
- Breakage

- Based on an inspection and diagnosis

How to service

- Refer to service manual information
- Replace worn/weak/broken
- Corrosion issues
- Special tools
  - Presses
  - Separators
  - Adaptors
- Always alignment afterwards

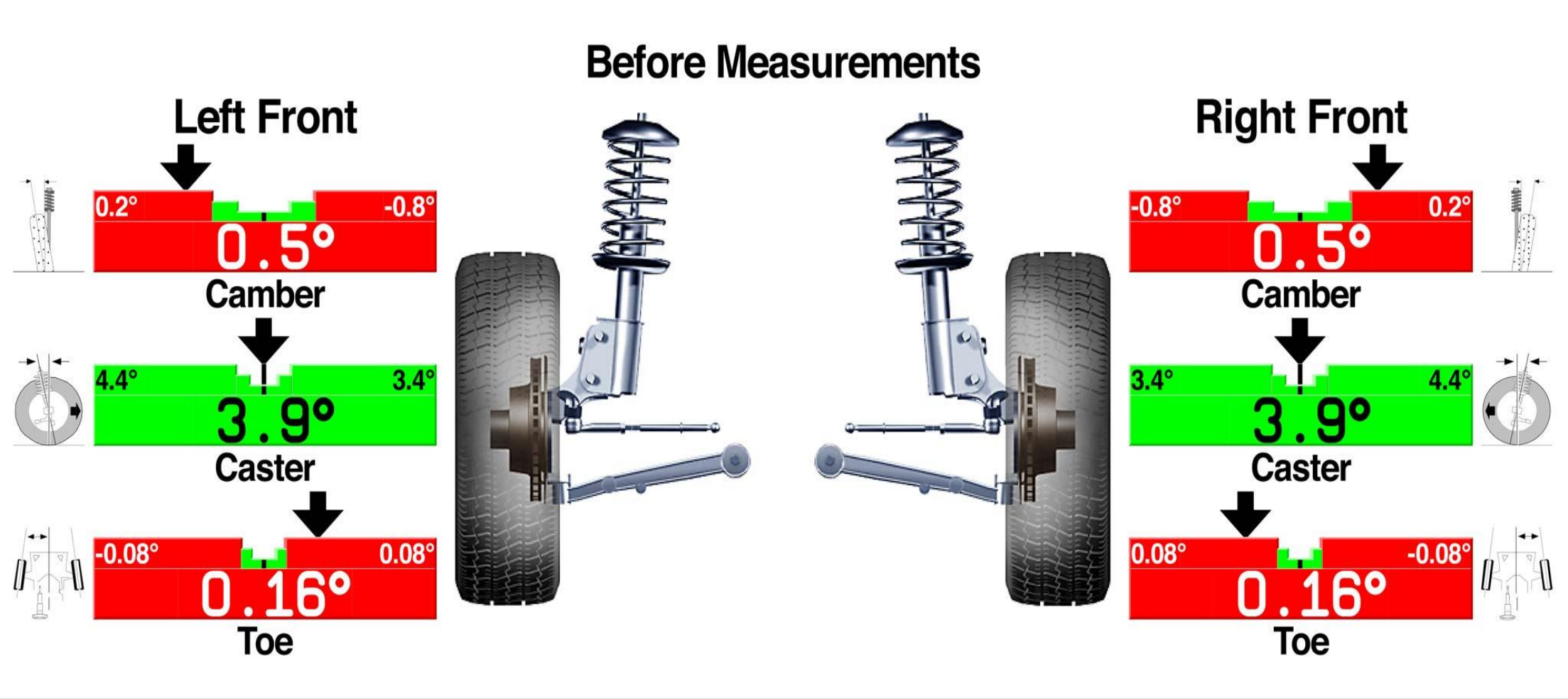


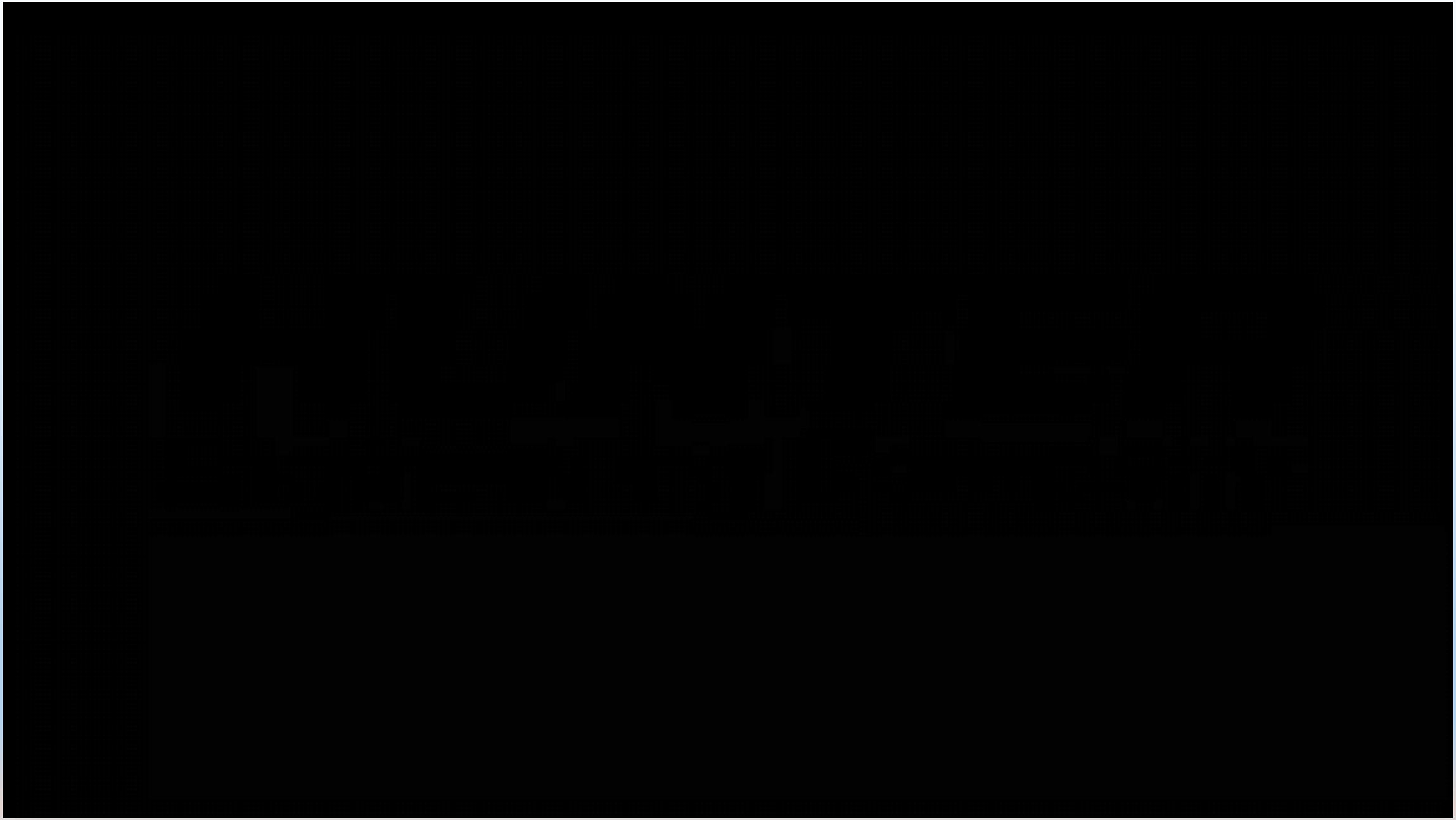


Pickle fork

Questions ????

Alignment


Before Measurements
Left Front
0.2°
-0.8°
0.5°
Camber
4.4°
3.4°
3.9°
Caster
-0.08°
0.08°
0.16°
Toe
Right Front
-0.8°
0.2°
0.5°
Camber
3.4°
4.4°
3.9°
Caster
0.08°
-0.08°
0.16°
Toe

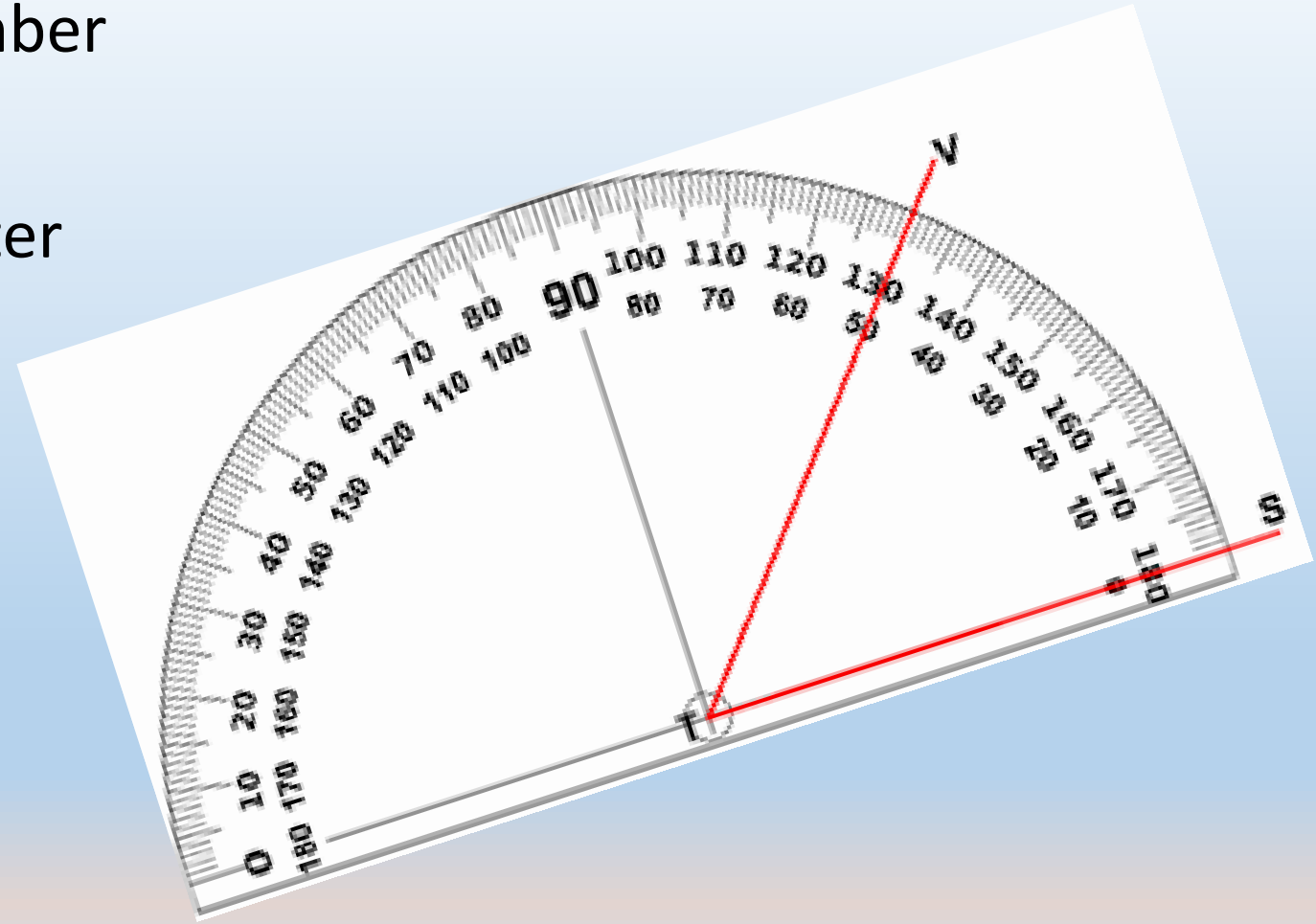


Alignment Related Problems

- Pull
- Lead Or Drift
- Road Crown Effects
- Wander
- Stiff Steering Or Slow Return To Center
- Tramp Or Shimmy Vibration
- Tire Wear
- Steering wheel off center

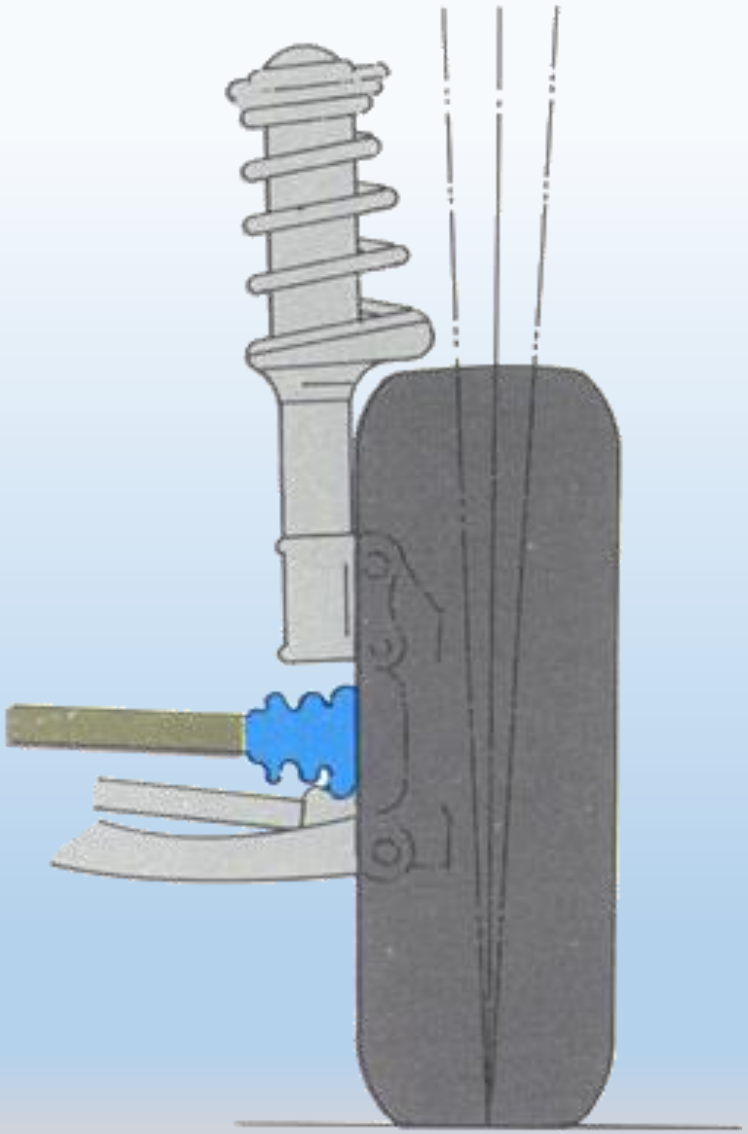
Critical Alignment Angles

- Camber
- Caster
- Toe



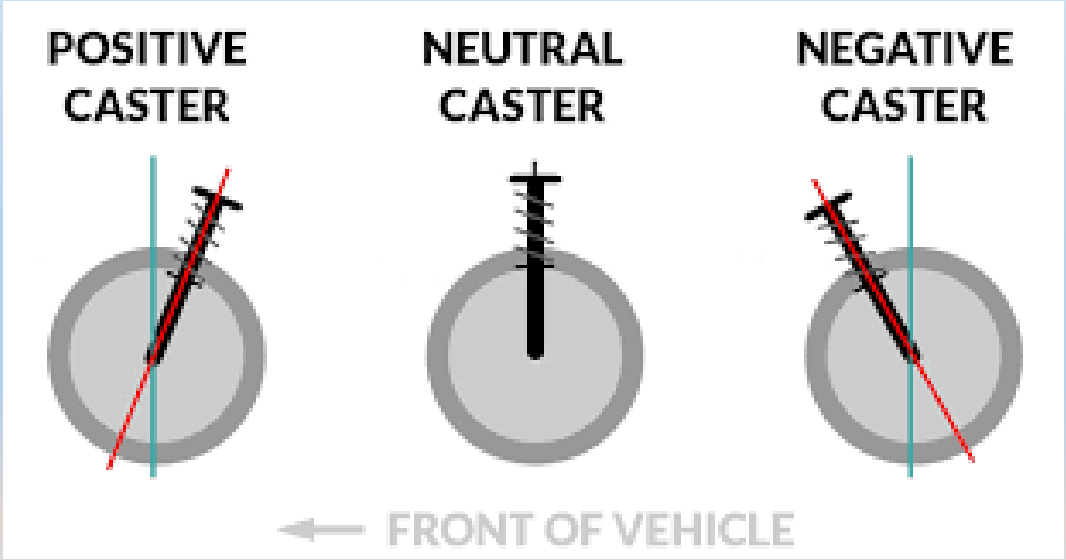
CAMBER

- Tire wearing angle
- Inward and outward tilt of the tires at the top
- Negative when the top is tilted “in”
- 0 degrees when vertical
- Pulls to side most positive camber



CASTER

- Forward or rearward tilt of the steering axis when compared to a true vertical line
- Caster is positive when the upper ball joint is rear
- Caster provides return ability and directional stability
- Pulls to the side with least caster

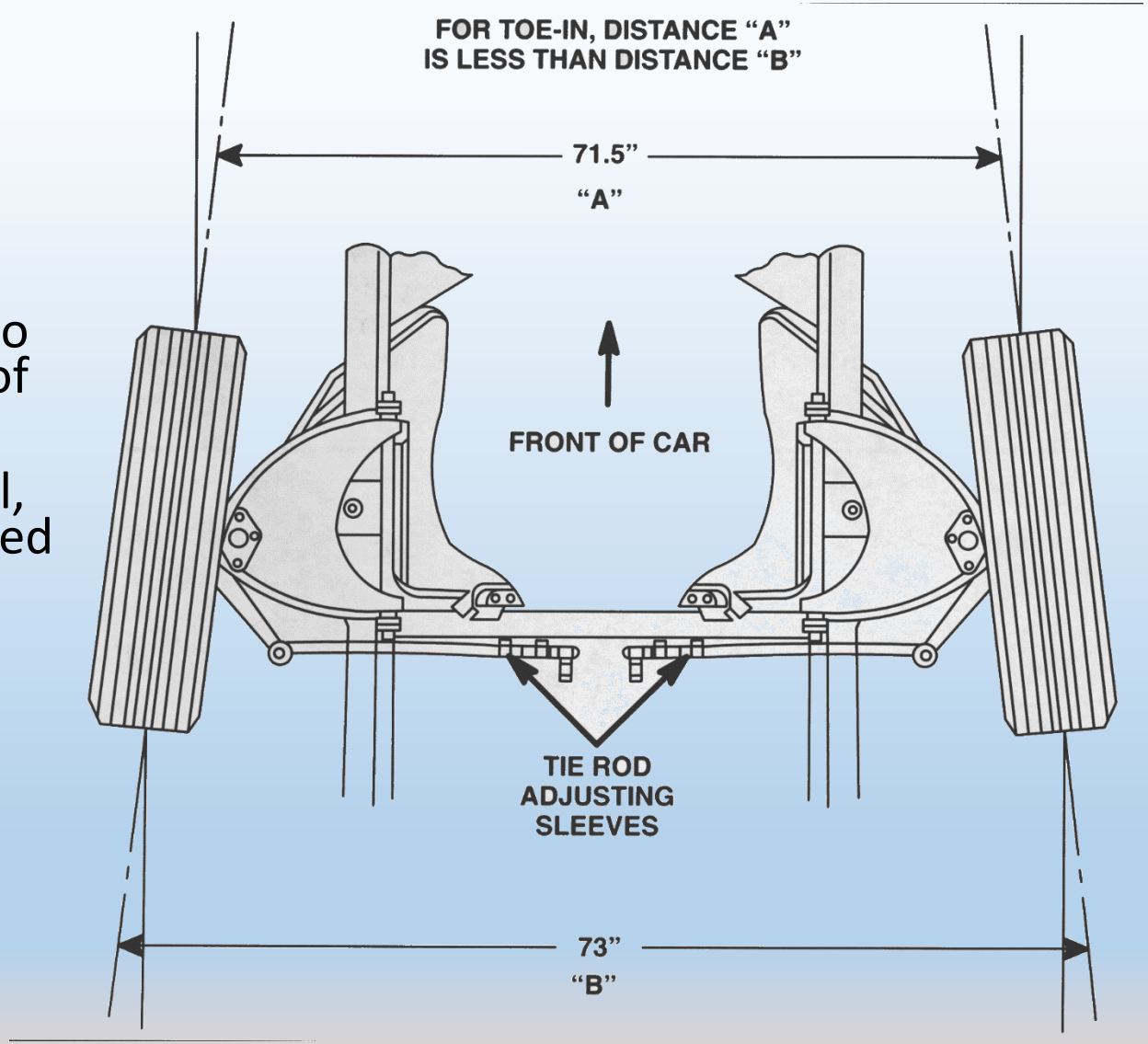


TOE

- Greatest tire wearing angle
- The distance between

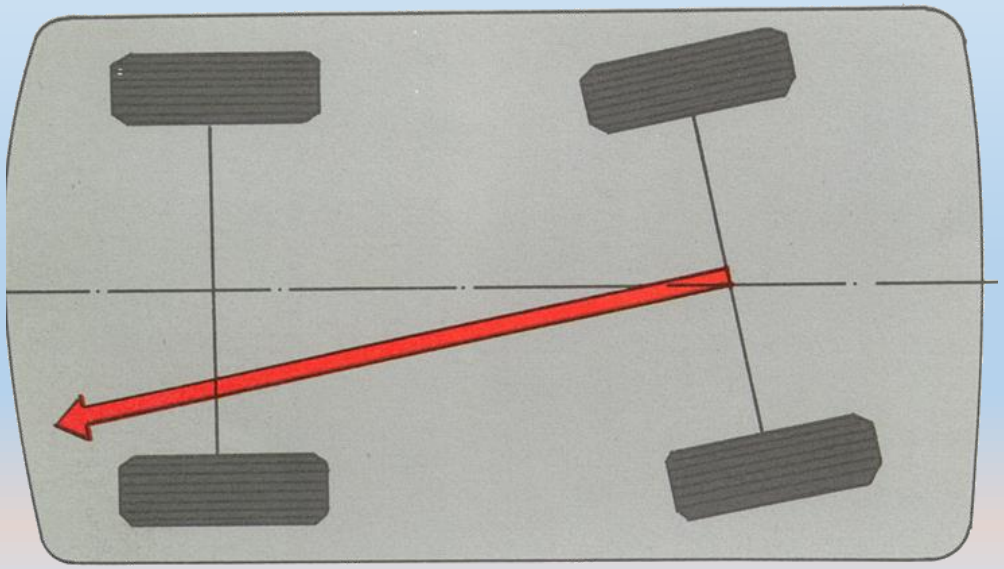
  the front of the tires compared to the distance between the rear of the same tires.
- Toe does not cause lead or pull, Thrust angle which can be changed by toe can cause a lead.

- Parallel = “0”
- Toe “in” equals Positive
- Total Toe (sum toe)
- Individual Toe



Thrust Angle

- Negative thrust angle forms to the left of the vehicle centerline
- Thrust angle can be created from improper rear toe
- Dog tracking
- Can cause steering wheel off center



Advanced diagnostic angles

- Steering angle Inclination
- Included angle
- Toe-out-on-turns
- Scrub radius
- Set-back
- Ride height

- Mostly used after an accident

Things to consider

- Always set tire pressure first
- Steering/suspension integrity
  - Could change alignment with play in components
- Steering angle sensor reset after align
  - relearn center
- Other advanced systems need calibrated?
  - ADAS
    - Collision avoidance systems
    - Lane keep assistance
    - Adaptive cruise control
    - Blind spot monitoring

Adjusting Alignment
changing align geometry

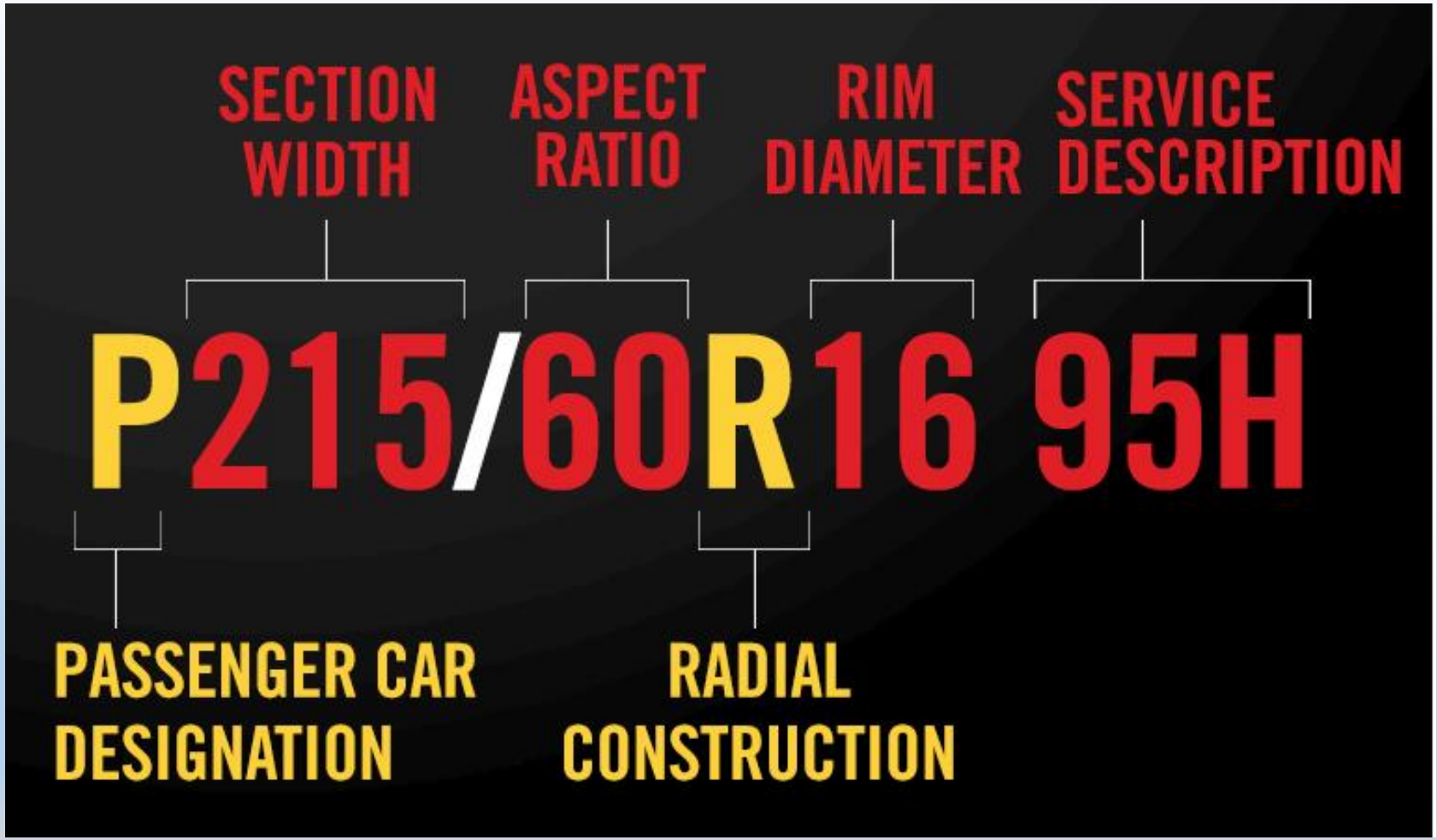
- Cams
- Eccentrics
- Slots
- Threaded rods
- Sub frame shift

- Aligner demo

Questions ????

Tires

Tire sizing


SECTION WIDTH
ASPECT RATIO
RIM DIAMETER
SERVICE DESCRIPTION
P215/60R16 95H
PASSENGER CAR DESIGNATION
RADIAL CONSTRUCTION

Service index

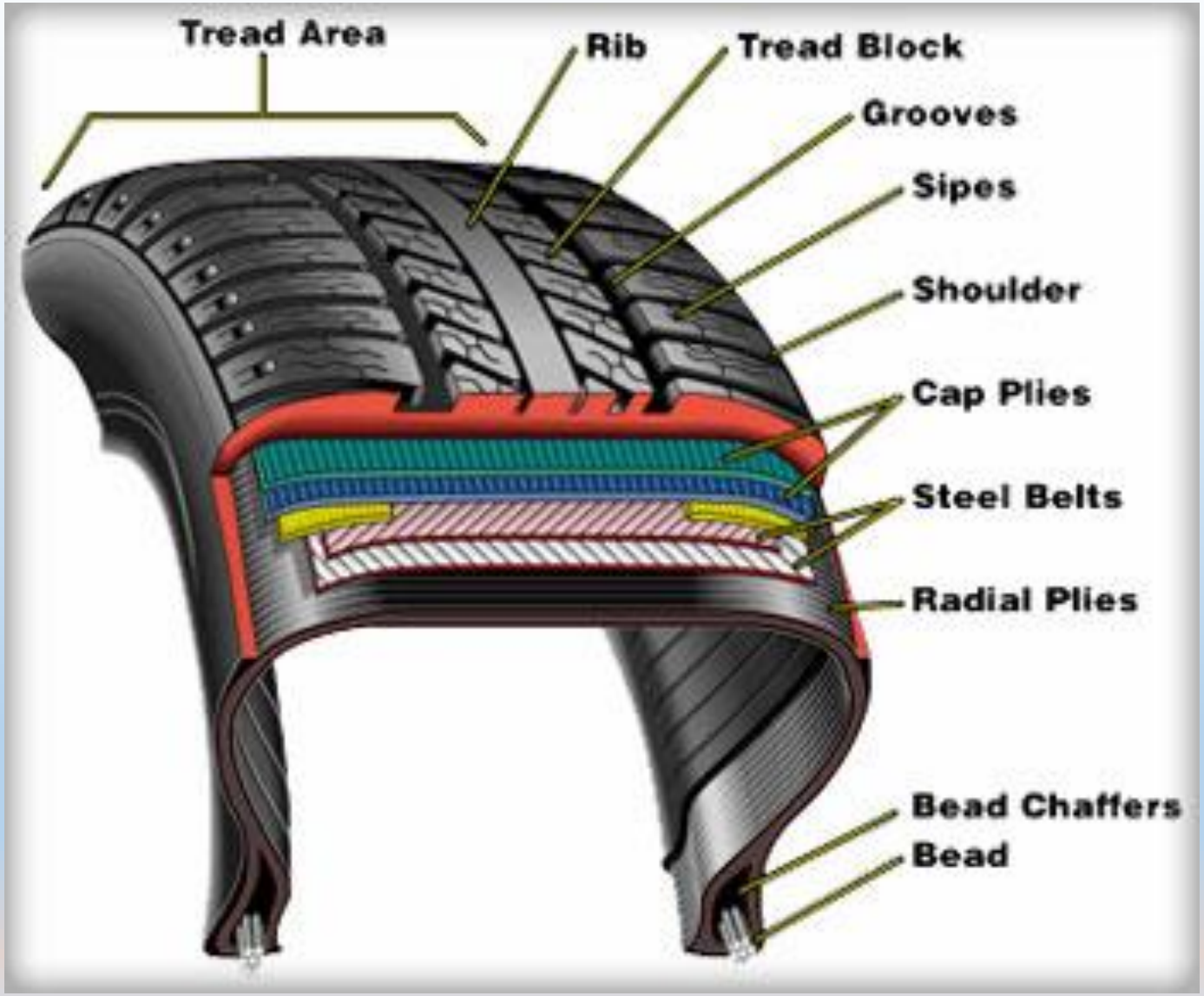
LOAD INDEX

LOAD INDEX	LOAD (lbs)	LOAD INDEX	LOAD (lbs)	LOAD INDEX	LOAD (lbs)
65	639	94	1477	123	3417
66	661	95	1521	124	3527
67	677	96	1565	125	3638
68	694	97	1609	126	3748
69	716	98	1653	127	3858
70	739	99	1709	128	3968
71	761	100	1764	129	4079
72	783	101	1819	130	4189
73	805	102	1874	131	4299
74	827	103	1929	132	4409
75	853	104	1984	133	4541
76	882	105	2039	134	4674
77	908	106	2094	135	4806
78	937	107	2149	136	4938
79	963	108	2205	137	5071
80	992	109	2271	138	5203
81	1019	110	2337	139	5357
82	1047	111	2403	140	5512
83	1074	112	2469	141	5677
84	1102	113	2535	142	5842
85	1135	114	2601	143	6008
86	1168	115	2679	144	6173
87	1201	116	2756	145	6393
88	1235	117	2833	146	6614
89	1279	118	2910	147	6779
90	1323	119	2998	148	6944
91	1356	120	3086	149	7165
92	1389	121	3197	150	7385
93	1433	122	3307		

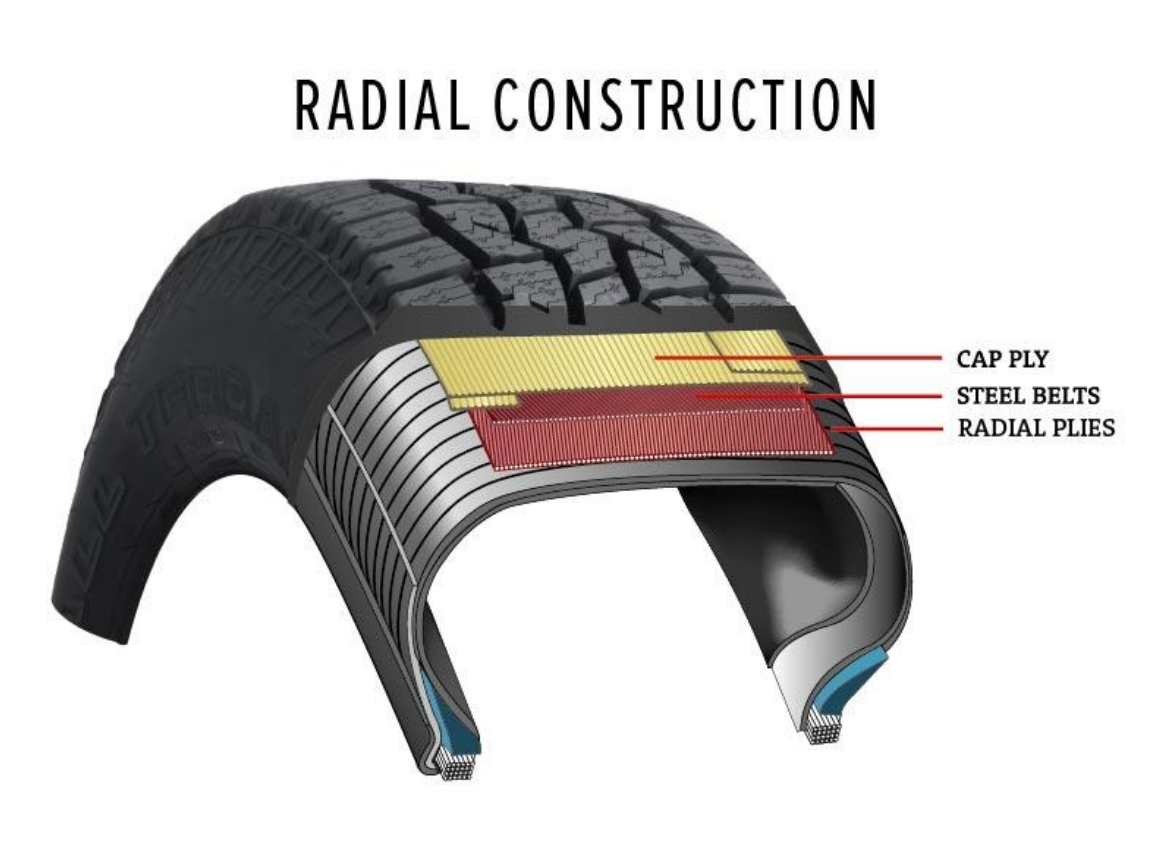
SPEED RATING

	SPEED SYMBOL	SPEED (mph)
	A1	3
	A2	6
	A3	9
	A4	12
	A5	16
	A6	19
	A7	22
	A8	25
	B	31
	C	37
	D	40
	E	43
	F	50
	G	56
	J	62
	K	68
	L	75
	M	81
	N	87
	P	93
	Q	99
	R	106
	S	112
	T	118
	U	124
	H	130
	V	149
	W	168
ZR*	Y	186
	(Y)	Above 186

*For tires having a maximum speed capability


Tread Area
Rib
Tread Block
Grooves
Sipes
Shoulder
Cap Plies
Steel Belts
Radial Plies
Bead Chaffers
Bead

Radial vs Bias tires



Tread depth

Uniform Tire Quality Grading System

- The U.S. Department of Transportation (DOT) and the National Highway Traffic Safety Administration (NHTSA)
- Developed a system of tire grading, the Uniform Tire Quality Grading System (UTQGS), to help customers better judge the relative performance of tires.
  - The three areas of tire performance are tread wear, traction, and temperature resistance.

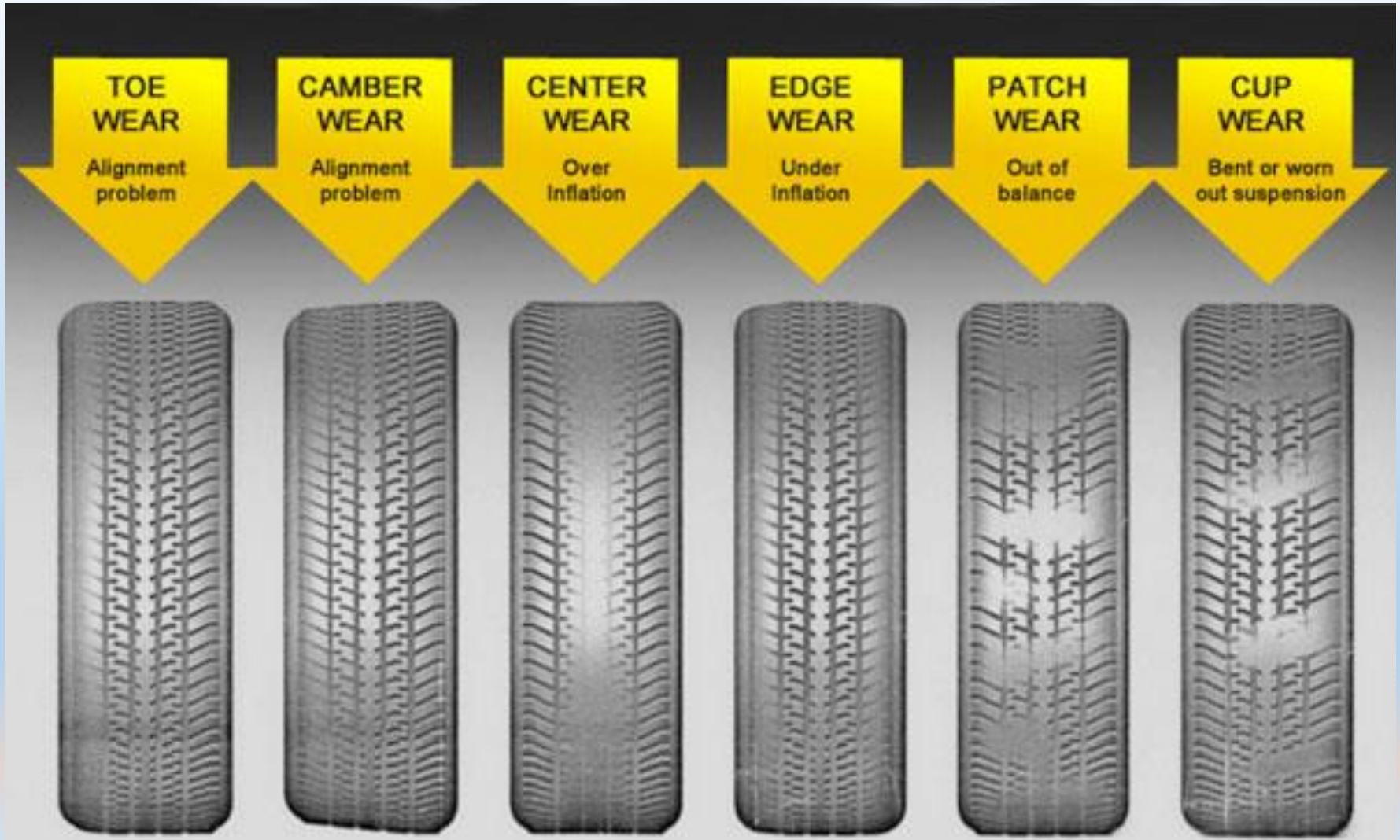
Dot Tire Code

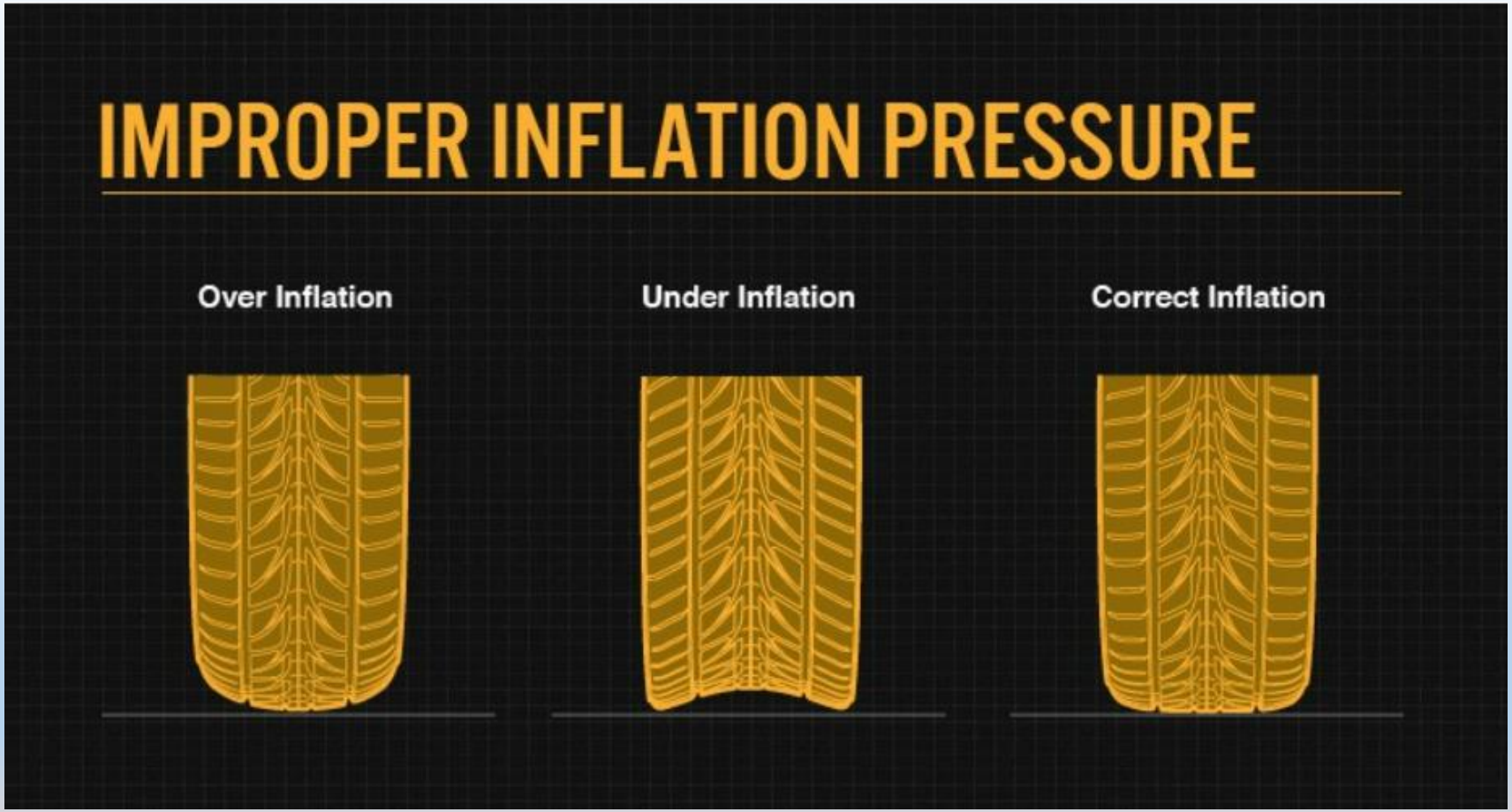
- All tires sold in the US must be approved by U.S. Federal Department of Transportation.
- The DOT tire code requirements include:
  - Resistance to tire damage that could be caused by curbs, chuckholes, and other common occurrences for a tire used on public roads.

Date Code

- Four numbers
- The first two= week of the year
- 05 = Fifth week
- Last two = year
- 13 = 2013
- Many vehicle and tire manufacturers says that tires over 6 years old should be replaced
- Never service a tire over 10 years old

Tire wear

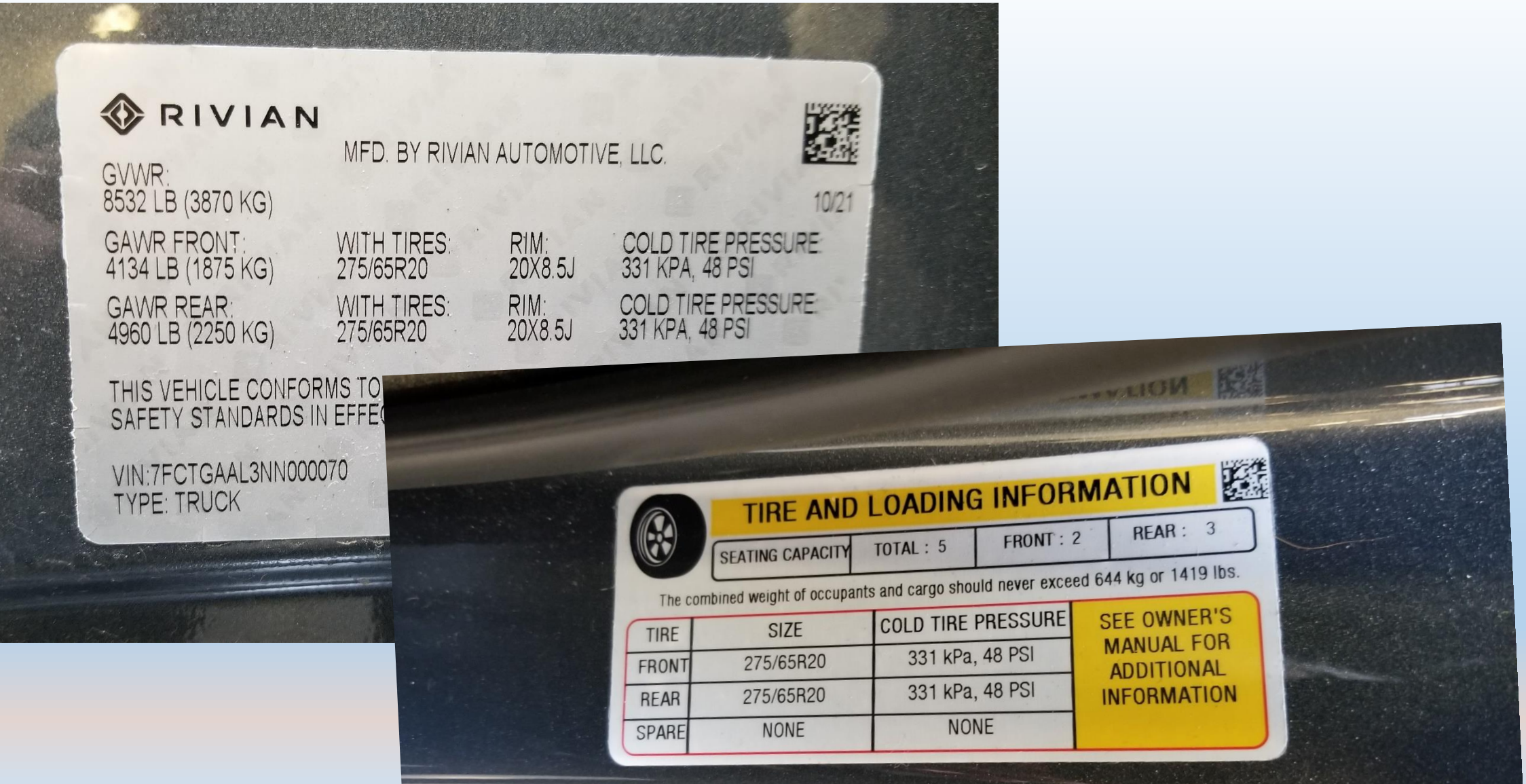

TOE WEAR
Alignment problem
CAMBER WEAR
Alignment problem
CENTER WEAR
Over Inflation
EDGE WEAR
Under Inflation
PATCH WEAR
Out of balance
CUP WEAR
Bent or worn out suspension


IMPROPER INFLATION PRESSURE
Over Inflation
Under Inflation
Correct Inflation

Tire wear

- Mis-use/abuse
- Pressure
- Worn or weak suspension &/or steering
- Alignment
- Balancing
- Lack of rotation
- Combination of any multiplies

Tire placard



Tire repair

Puncture Repair Procedures for Passenger and Light Truck Tires

The excerpts are cited from the U.S. Tire Manufacturers Association's "Puncture Repair Procedures for Passenger and Light Truck Tires" wall chart, which contains the industry recommended puncture repair procedures.

Repairs must be performed by **removing the tire from the rim/wheel** assembly to perform a complete inspection to assess all damage that may be present. Repairs are limited to the **tread area only** *(see graphic)*.

A plug by itself or a patch by itself is an unacceptable repair.

Puncture injury cannot be greater than **1/4-inch** (6mm) in diameter; DO NOT make repairs where the injury damage extends into the shoulder/belt edge area OR where the injury extends at an angle into the shoulder area. If there is any question that the injury extends into the shoulder/belt edge area, then the tire must be taken out of service.

For complete USTMA puncture repair procedures, see "Puncture Repair Procedures for Passenger and Light Truck Tires" wall chart or visit www.ustires.org.

Repairs **cannot overlap**. A rubber stem, or plug, must be applied to **fill the puncture injury** and a patch must be applied to seal the innerliner. A common repair unit is a one-piece combination unit with a stem and patch.

Not all tires can be repaired. Specific repair limits should be based on recommendations or repair policy of the tire manufacturer and/or type of tire service.

NEVER repair a tire that has an existing, improper repair; the tire must be scrapped.

NEVER perform an outside-in tire repair or on-the-wheel repair.

Ask your tire service professional if industry repair procedures are used. Also, some tire manufacturers may have repair limits or restrictions for some tires, such as runflat tires and others.

U.S. TIRE MANUFACTURERS ASSOCIATION

1400 K St, NW, Washington, DC, 20005
202-682-4800 • Fax 202-682-4854
www.ustires.org

Tire repair

*** IMPORTANT!**

- **Not all tires can be repaired.** Specific repair limits should be based on recommendations or repair policy of the tire manufacturer and/or type of tire service (e.g. service description, run-flat technology, commercial service applications, etc.).

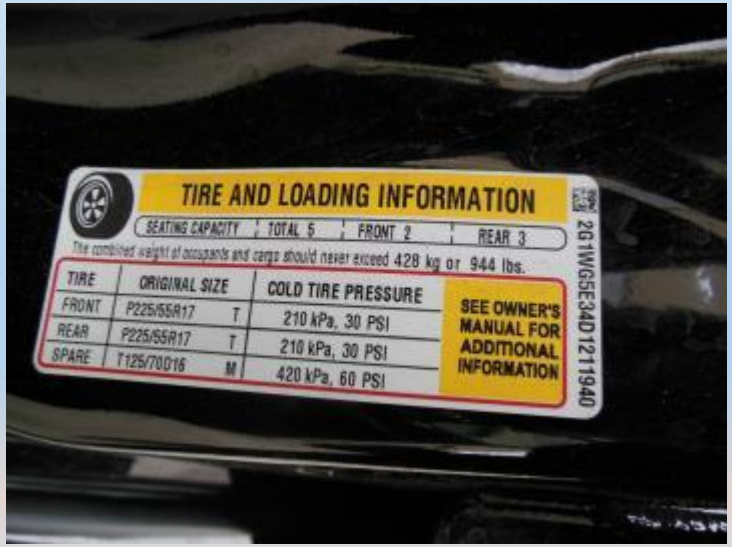
- **For all tires, repair units cannot overlap.** The number of repairs should be limited first by the tire manufacturer's recommendations and repair policy and then by application and the individual tire's condition as determined by the inspection process detailed in Steps 1 and 2.

- **Some run-flat technology tires cannot be repaired.** Consult tire manufacturer for their repair policy and, if applicable, for their recommended repair procedures.

- **Industry recommended repair methods include:** (1) Two-piece stem and patch repair components, and (2) one-piece patch/stem combination repair units. For punctures angled greater than 25°, two-piece stem and patch repair components are recommended (see Step 2). **NEVER** use only a plug (stem) or **NEVER** use only a patch to repair a puncture.

TREAD ACT

- Effective 2007 and newer model year (MY).
- Requires that a warning light when pressure drops 25% of the cold inflation pressure as shown on the door placard



Pressure and Temperature

- Cold Placard Inflation pressure
- Tire pressure changes 1 PSI for each 10 degree (F) change in temperature.
- From 70 degrees down to 30 degrees means a drop of 4 PSI.

TEMPERATURE	TIRE PRESSURE (PSI)	CHANGE FROM COLD PLACARD INFLATION PRESSURE
120°F (49°C)	37	+5
110°F (43°C)	36	+4
100°F (38°C)	35	+3
90°F (32°C)	34	+2
80°F (27°C)	33	+1
70°F (21°C)	32	0
60°F (16°C)	31	−1
50°F (10°C)	30	−2
40°F (4°C)	29	−3
30°F (−1°C)	28	−4
20°F (−7°C)	27	−5
10°F (−12°C)	26	−6
0°F (−18°C)	25	−7
−10°F (−23°C)	24	−8
−20°F (−29°C)	23	−9

TPMS

- Direct
  - Sensor in tire to measure PSI
  - More issues with service and repair

- Indirect
  - Does not measure PSI
  - Calculates PSI
  - Uses wheel speed sensors
  - More issues with relearning

TPMS

- Flashing light
  - Fault with the system
    - Battery
    - Bad sensor
    - Poor RF transmission
- Solid warning light
  - Low tire condition

Questions ????