Brake Operating Principles

State the Major Functions of the Brake System
Stop The Car
Hold the car when parked

What is required to stop the car?
ENERGY
Energy is neither created nor destroyed

What is energy in motion called?  
Kinetic Energy

What happens to the energy when a vehicle stops?  
Turns in to HEAT
\[
mv^2 / 29.9 = E_k
\]

As **mass** doubles the energy doubles

As **speed** doubles the energy **quadruples**

A vehicle that weighs 4 tons needs twice the stopping power of a 2 ton vehicle

A vehicle traveling at 100 mph needs how much more stopping power from one going 50 mph?

**FOUR TIMES AS MUCH HEAT!**
How can you stop faster?

Step on the pedal harder!
    Increasing pressure increases friction

What happens if you stop twice as fast?

The brakes build FOUR TIMES as much heat
Braking Principles

Where does the heat go?
- Into the brake drum or rotor
- Into the air
- Into the brake fluid
Brake Linings

How do brake linings turn kinetic energy into heat?

**FRICTION**

Coefficient of friction = how slippery or sticky

The friction coefficient is changed by:

- Surface finish of drum or rotor
- Materials used in the brake lining

Heat
Brake Linings

What happens to overheated brakes?
  Heat Fade

What types of heat fade are there?
  Lining Fade (too hot)
  Mechanical Fade (drum brakes only)
  Gas Fade (way too hot...ruins brakes)
What other kinds of brake fade are there?

Water Fade
(Hydroplaning for the brakes)

Boiled Brake Fluid
(Water in fluid turns to gas)
How to avoid brake fade?

Proper surface finish of drums & rotors
(do not machine past limits)

Use of Premium brake lining material

Flush brake fluid at each brake job
(this gets rid of water in fluid)
How to avoid brake fade?

Insure all air cooling is in place
  directional wheels
  directional rotors
  splash shields in place
SLOW DOWN
Insure hydraulic control valves are working
So what is important to remember?

- Brakes generate HEAT
- Too much heat causes brake fade (failure)
- Proper friction material, rotor/drum condition and cooling is critical to safety
- Brake fluid condition is critical for safety
Basic Hydraulic Brakes
Brake Operating Principles

Pascal’s Law states that pressure is equally applied to all areas within a closed hydraulic system. Force = Pressure x Area

This works because Liquid cannot be compressed.
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Pascal’s Law DEFEATED!
Gas, Vapors, Air, Boiled Water, can ALL be compressed
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All Air must be bled from brake lines

Water contaminated brakes can boil when they get HOT
Pedal Freeplay & Pedal Reserve
Pedal Freeplay & Reserve

common free play adjustment is between 1/16” to 1”

Critical to check if replacing Master Cylinder

Insufficient Pedal Reserve is Dangerous!

Why can cause poor pedal reserve?

Worn bushings & Linkage or Hydraulic defects
Brake Pedals

Effective travel

How far the pedal actually moves not counting freeplay
Pedal reserve

How far pedal is from floorboard when brakes are fully applied.
Brake Pedal and Cylinder Service

List consequences of misadjusted or worn brake pedal linkage
- decreased pedal reserve
- decreased effective travel
both can be caused by worn linkage.

No pedal freeplay will keep brakes applied!
Piston Seal
Vent Port or Compensating Port
Replenishing Port
Primary Cup
secondary Cup
Vent Port MUST OPEN when brakes are OFF
No Pedal Free Play can cover Vent Port causing pressure to remain in brake system
Check pedal adjustments

- perform a brake pedal inspection **BEFORE** checking free play
  - check for binding or extra loose bushings

Measure free play and pedal reserve with ruler

Check adjustment - operation of stoplights
Pedal Reserve Distance

Pedal Freeplay
Dual Piston Master Cylinder

- All modern master cylinders are required to be dual piston/dual reservoir
- They will be split diagonal or front to rear
- Loss of pressure in one circuit will still allow pressure to operate two wheel brakes
Normal Master Cylinder operation
Normal Master Cylinder operation
After replacing Master Cylinder or Power Booster or Adjusting brake pedal or installing – adjusting brake light switch

REMOVE TOP OF MASTER CYLINDER

To check to make sure vent ports are open
No pedal Freeplay or misadjusted push rod blocks the vent port and causes brakes to self apply when they heat up!

(Stop light switch can also block vent port)
Bypassing Master Cylinder
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Bypassing master cylinder causes low or sinking pedal with no loss of brake fluid
Master Cylinder Failures

External leaks
typically at rear of master cylinder
may require loosening cylinder from booster

Bypassing
reservoir level may rise as pedal is depressed

distorted, worn diaphragm is also common
may indicate oil contamination
Impact Wrench Use

• Use air impact wrench to quickly remove lug nuts

• ALWAYS torque lugnuts to specification

• Look it up for EVERY car
Left-handed Wheel Studs

Some vehicles have left handed wheel studs

Found on older automobiles (1950’s & 60’s)

Always be careful with the impact wrench