



FACT SHEET

Module 4.1

Braking Systems

BRAKING SYSTEMS

The **brake system** permits the driver to slow or stop the rotation of the tires. The friction of the tires against the road surface will then slow and/or stop the vehicle. Traction is measured by the ability to stop a car in straight-ahead motion on a wet surface.

Modern vehicles are equipped with two braking systems:

- Dual hydraulic brake system.
- Mechanical brake system (parking or emergency brake).

Good brakes are essential for the safe operation of a vehicle. The life expectancy and performance of a vehicle's brakes depend on how they are used and maintained.

The basic components of a brake system include:

Disc brakes—superior brakes (cool faster) that utilize a pinching action on a metal disc to slow or stop tire rotation of the tire. Disc brakes are usually at the front wheels. The front brakes do 70% of the braking. Disc brakes are available as an option at all four wheels.

Drum brakes—brake shoes push outward on a rotating drum. Because they are enclosed, they retain heat.

Anti-Lock Brakes--- When a driver operating a four-wheel ABS-equipped vehicle steps firmly on the brake pedal, the system automatically modulates the brake pressure at all four wheels, adjusting pressure to each wheel independently to prevent wheel lock-up.

Dual Master Cylinder—brake pedal applies pressure on two pistons that pressurize the brake fluid. The fluid transmits this pressure to each wheel where it activates the disc or drum brake mechanism. A reservoir (sometimes two) supplies extra fluid when needed. The dual systems operate independently in case one should fail.

Brake lines—double-walled steel tubes full of brake fluid that conduct the hydraulic pressure.

Power brake—an engine-activated booster unit that reduces the effort required to apply the hydraulic brakes. The power brake will operate one more time if the engine should stop functioning.

Parking brake—a lever or foot pedal that mechanically (cables and levers) activates the rear brakes only (most vehicles). Can be used for parking and if the hydraulic brakes fail.

Indicator light—comes on if one of the dual hydraulic brake systems should fail or, in some vehicles, if the brake fluid is low. If this occurs, have a service technician check the problem.

Braking distance is the distance a vehicle travels once the brakes are applied. A driver's experience and skill in braking, the kinetic energy of the vehicle, the mechanical condition of the vehicle, and road conditions all come into play. What does this mean?

- A vehicle going 20 mph can stop within 20 feet.
- A vehicle going 40 mph takes 80 feet to stop.
- A vehicle going 60 mph stops at 180 feet.

Notice the vehicle in the last two examples increased by 20 mph each and how much further the vehicle traveled in the braking distance.

Other factors that affect braking distances:

- **Vehicle condition**—a poorly maintained vehicle takes longer to stop.
- **Roadway surface**—rain, snow, ice, dirt, wet leaves, and gravel reduce road traction and increase stopping distance.
- **Hills**—braking distance increases when driving downhill.
- **Loads**—heavy loads increase your braking distance.

Antilock Braking System (ABS)

If the vehicle has ABS, the driver can better control steering while braking. In a hard braking situation, the pedal will vibrate or chatter. This is normal. The driver's foot must stay firmly planted and the pedal depressed to the floor for the ABS brakes to work properly.



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Braking Distance Chart

TIME	20mph	30mph	40mph	50mph	60mph	70mph
Perception time 1.1 x speed	22	33	44	55	66	77
Reaction time 1.1 x speed	22	33	44	55	66	77
Braking distance = Speed ² x .0390 <small>Coefficient of friction = .085 on dry concrete</small>	16	35	63	98	142	192
TOTAL BRAKING DISTANCE	80	101	151	208	274	346
Braking distance = speed ² x .0418 <small>Coefficient of friction = .080 on dry concrete A more conservative multiplier based upon the fact all cars on the road are not new and braking systems are not new.</small>	17	38	67	105	150	204
TOTAL BRAKING DISTANCE	81	104	155	215	282	358

Time	20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50 mph	55 mph	60 mph	65 mph	70 mph	75 mph
Perception time <small>¾ second</small>	22	28	33	39	44	50	55	61	66	72	77	83
Reaction time <small>¾ second</small>	22	28	33	39	44	50	55	61	66	72	77	83
Braking distance Speed ² x .0390	16	25	35	48	63	79	98	118	142	165	192	219
TOTAL BRAKING DISTANCE	60	81	101	126	151	179	208	240	274	309	346	385
Braking distance speed ² x .0418	17	26	38	51	67	85	105	126	150	177	204	235
TOTAL BRAKING DISTANCE	81	82	104	129	155	185	215	248	282	321	358	410



WORK SHEET

Module 4.1

Calculating Braking Distances

Name _____

Date _____

Score _____

Feet Per Second Calculation

One mile = 5,280 feet

One hour = 3,600 seconds

$$5,280 \div 3,600 = 1.46666 \text{ feet (1.467) per second a vehicle will travel}$$

Use 1.467 feet/sec to calculate distance traveled for all speeds

Example: 40 mph X 1.467 = 59 feet per second traveled at 40 mph

Simplified method not as accurate, but close:

Speed $\div 2$ = a number, + speed = feet per second traveled

Example: 40 mph $\div 2$ = 20 + 40 mph = 60 feet per second traveled at 40 mph

Reaction Time Distance Calculation

Average reaction time is 3/4 of a second (.75) (driver is alert and ready to react)

To calculate reaction time distance:

speed X feet per second traveled X .75 (reaction time) = feet traveled during reaction time

Example: 40 mph X 1.467 x .75 = 44 feet traveled during reaction time

Example: 40 mph $\div 2$ = 20 + 40 mph = 60 X .75 = 45 feet traveled during reaction time

Braking Distance Calculation

Speed X Speed $\div 10 \div 2$ = Average Braking Distance

Example: 40 mph X 40 mph $\div 10 \div 2$ = 80 feet to stop at 40 mph

Total Stopping Distance

Reaction Time (speed X 1.467 X .75) + Braking Distance (Speed X Speed $\div 10 \div 2$) = Average Stopping Distance

$$\begin{array}{r} \text{Example: } 40 \times 1.467 \times .75 + (40 \times 40 \div 10 \div 2) = \\ 44 \quad \quad + \quad \quad 80 \quad \quad = 124 \text{ feet Average Stopping Distance} \end{array}$$

Calculate the following:

SPEED (S)	Feet per second traveled $S \times 1.467 \text{ ft/sec} =$	Reaction Time Distance $S \times 1.467 \times .75 =$	Braking Distance $S \times S \div 10 \div 2 =$	Total Stop Distance Reaction Distance + Braking Distance=
20mph				
30mph				
40mph	$40 \times 1.467 =$ 59 ft/sec	$40 \times 1.467 \times .75 =$ 44 feet	$40 \times 40 \div 10 \div 2 =$ 160 feet	44 feet + 160 feet = 204 feet
50mph				
55mph				
60mph				
65mph				
70mph				
75mph				
80mph				