Braking Distance

When applying the brakes in your car, there is friction created between the brake pads and the rotating wheel. This friction causes the car to slow down and eventually stop. From the time you apply the brakes until the time you come to a complete stop, the car continues to move. The distance you cover while braking is called the **braking distance**.

A person's reaction time also has an impact on the distance you cover while coming to a stop. **Reaction time** is the amount of time it takes for you to recognize a situation and react to it. For example, if you see a dog run out in front of your car, you process this information and decide that you need to apply the brakes. The amount of time it takes you to make and execute this decision is your reaction time. During this time, your car is still moving, and you haven't even hit the brakes yet.

A person's reaction time can be negatively affected by a number of factors:

- Alcohol
  - alcohol is a depressant and will slow your reaction time
- Hallucinogenic Drugs
  - these drugs inhibit the nervous system, slowing reaction time
- Depressant Drugs
  - these drugs slow down your body's activity levels, slowing reaction time
- Driver Fatigue
  - the more tired you are, the slower your reaction time
- Cold and Allergy Medications
  - many over the counter medications can cause drowsiness, which slows your reaction time
- Age
  - in general, as you get older, your reaction time slows down

Even if you have a fast reaction time and are wide awake, your braking distance can sometimes be longer than expected. There are some factors that can affect stopping distance that are simply out of your control. Most of these factors have to do with road condition. When driving conditions are slippery, wet, snow-covered, or treacherous in any way, braking distance may be affected.

While you cannot control road conditions, you must anticipate longer braking distances and drive accordingly. This means slowing down and giving yourself plenty of room to stop.

Finally, there are factors that affect braking distance that have to do with the state of repair of your vehicle. Are your brakes in good condition? Do you have enough tread left on your tires?

The Mathematics of Braking Distance

The total stopping distance of a vehicle must take into account two things: the distance traveled during the reaction time of the driver, and the distance traveled while actually applying the brakes. In other words:

$$\text{total stopping distance} = \text{reaction time} + \text{braking distance}$$

During the driver's reaction time, the vehicle continues to move with a constant velocity. Thus, the distance travelled during the reaction time can be calculated using:

$$d = v \times t$$

The distance traveled while braking depends on how fast the car is moving, and on the road conditions. It can be calculated using:

$$d = k \times v^2$$

where v is the speed of the car in m/s, and k is a constant (called the **frictional constant**) representing the condition and type of driving surface. Some examples of possible frictional constants are given below:

Rubber tire on:	**Frictional Constant**
dry pavement	0.06
wet pavement	0.10
snow and ice	0.15

So, the total stopping distance would be given by:

$$\text{stopping distance} = \left(v \times t\right) + \left(k \times v^2\right)$$

Example
Calculate the total stopping distance for a car that is traveling at $60\ km/h$ $(16.7\ m/s)$ on a wet road. Use 1.75 seconds as the driver's reaction time.

Worksheet

1. Describe the relationship between reaction time and braking distance.

2. Explain why drinking and driving don't mix.

3. Identify three substances that, when ingested, will have a negative effect on reaction time.

4. Explain why braking distance on a gravel road is greater than on a paved road.

5. When getting behind the wheel of your car, what factors should you consider in order to prepare your self for the required stopping distance?

6. Calculate the braking distance for a car traveling at $30\ km/h$ $(8.3\ m/s)$ and a car traveling at $90\ km/h$ $(25\ m/s)$ on a wet road. Once you have finished your calculations, complete the following sentence:

   A car that is traveling 3 times faster will require _____ times as much distance to come to a stop.

7. The light turns yellow at an upcoming intersection, which is 85 meters away. You are traveling at $60\ km/h$ $(16.7\ m/s)$ on dry pavement. Your reaction time is 0.5 seconds. Will you be able to stop before entering the intersection?

8. Calculate the braking distance for a car traveling on wet pavement at

   a) $50\ km/h$ $(13.9\ m/s)$

   b) $80\ km/h$ $(22.2\ m/s)$

   c) $90\ km/h$ $(25\ m/s)$

   d) $100\ km/h$ $(27.8\ m/s)$

9. Determine the total stopping distance for a car traveling at $108\ km/h$ $(30\ m/s)$ on a snow covered highway. Assume the driver's reaction time is 1.25 seconds.