

CHAPTER 13 OBJECTIVES

LESSON ONE



Natural Laws and the Movement of Your Car

1. Describe the natural laws of inertia, friction, momentum, kinetic energy, and gravity, and explain each one's relationship to driving.

LESSON THREE



Using Natural Laws to Manage Skids

6. List factors that can cause your car to skid.
7. Name and describe the kinds of skids there are.
8. Describe how to manage risk in responding to a skid.

LESSON TWO



Natural Laws and Steering and Braking

2. Explain how natural laws affect a car's stopping distance.
3. Identify the factors that affect steering.
4. Name the ways that natural laws affect steering around a curve.
5. Describe how gravity and the contour of the road affect steering.

LESSON FOUR



Natural Laws, Risk Management, and Collisions

9. Explain how speed control can help you avoid a collision.
10. Describe how knowledge of natural laws can help you avoid a collision.
11. Tell how to minimize the risks of a collision.

Does this sound familiar? You're in a car and the driver brakes. The car stops, but your books on the backseat continue moving forward onto the floor. Why did this happen? A natural law is the culprit.

What Are Natural Laws?

Natural laws are always at work. Some of these laws are inertia, friction, momentum, kinetic energy, and gravity.

Inertia

Inertia causes your books on the backseat to continue moving forward even after you brake. Two aspects govern inertia. One is that objects at rest do not move unless some force acts on them. The other is that moving objects continue to move in a straight line.

All things have inertia. As the car was moving, so were your books. When the driver braked, it exerted a force to make the car stop, but your books kept moving forward in a straight line. Then they fell to the floor.

You have to know about inertia when you drive because you and your passengers have inertia. If you brake the car hard, everyone will tend to keep moving forward. Drivers must manage risk by anticipating how to reduce inertia's effects.

One way to do this is to wear safety belts. These belts provide a force that acts against inertia. If you don't wear safety belts, you may be thrown forward against the windshield or dashboard if the brakes are applied hard.

Another way to manage risk is to be sure to secure all loose objects, such as your books.

Friction

Press your foot down hard on a carpeted floor. Keep it pressed down as hard as you can and try to move across the carpet. Does it feel as if some kind of force is trying to stop your foot from moving, almost as if your foot and the carpet are sticking together?

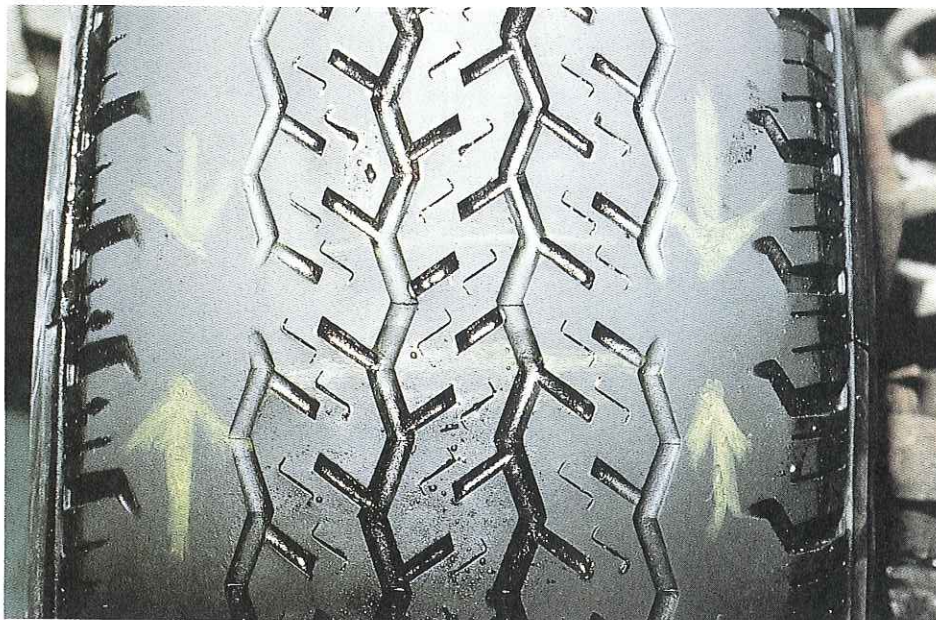
The force that seems to try to make the surface of your shoe "stick" to the surface of the carpet is *friction*. Friction is a force between two surfaces that resists the movement of one surface across the other. You can make your foot move across the car-



Tips for New Drivers

Drying the Brakes

Wet brakes do not work as efficiently as dry brakes. After you have driven through heavy rain or deep puddles, check for wet brakes. If you apply the brakes lightly and the car pulls to one side or does not slow, your brakes are probably wet. Dry the brakes by driving slowly with your left foot applying light pressure on the brake pedal. The friction created will generate heat, which will dry the brakes.



◀ The minimum legal—though not necessarily safe—tread depth for your tires is $\frac{1}{16}$ inch. To check your tire's tread depth, examine the tread-wear bars that are built into the tire. When the tread-wear bars are even with the surface of the tread at more than two spots around the tire, the tire is no longer legal or safe to use.

pet by applying more force than friction can resist or overcome.

Just as friction tries to make your foot stick to the carpet, it tries to make the surface of your tires “stick” to the surface of the road. Your car has to overcome friction in order to move. Your car stays on the road, however, because a certain amount of friction is always present.

Friction between the road and your tires is called *traction*, or *adhesion*, which means “sticking together.” Adhesion or traction holds your car on the road. Here are some factors affecting traction.

Tire pressure Tires are made with grooved surface treads that grip the road. For best traction, inflate tires to the pressure recommended by the manufacturer. Properly inflated tires grip the road evenly. Under- or overinflation reduces traction. If you underinflate your tires, only the outer edges grip the road. If you overinflate them, only the centers tend to contact the road.

Tire condition Would you try to walk on slippery packed snow or ice with rubber boots worn smooth? Of course not! You would slide all over. The same concept applies to tires. Bald tires—tires with very little or no tread—provide almost no traction on wet, icy, or snow-covered roads. Even on dry roads, bald tires reduce directional control, particularly if there is sand or debris on the road, and are more apt to get punctured.

Rain When the road is wet, water gets between the surface of the road and the tires. At 55 mph, a car can lose contact with the road surface if the water is as shallow as $\frac{1}{12}$ inch. Water provides a smooth surface for the tires to move across, and a smooth surface does not provide good traction. If tires are properly inflated and have good tread, much of the water will go into the grooves between the treads. This means that the treads themselves will come in contact with less water and more road surface.

Snow and ice make a roadway slick, reducing friction between your car and the road's surface. ▶



Ice and snow Ice and snow can reduce traction more than rain. Traction is poorest near 32°F, when snow and ice start to become a slippery, watery slush. Any road is dangerous when covered with ice or snow, so don't drive at these times unless absolutely necessary.

Snow tires help to increase traction in snow, but not necessarily on ice. Chains are helpful in increasing traction on ice, but they provide poor traction on pavement. In states where they are allowed, studded tires can help on ice but are not as effective as chains. All-weather tires are a good choice for most drivers.

Road condition Road condition also affects traction. Rough roads and potholes make your car bounce up and down, reducing traction. Wet leaves on the road also reduce friction, causing the wheels to lose traction and slide.

Momentum

If a 12-pound bowling ball and a 16-pound bowling ball were rolling toward an object at the same speed, which ball would cause more damage? Because it is heavier, the 16-pound bowling ball would.

Momentum is the product of weight and speed. It provides an explanation for what seems obvious in the bowling ball example. All objects in motion have momentum. The greater the momentum of the vehicles, the greater the damage in a collision might be.

A vehicle's momentum depends on weight and its speed. If either the weight or the speed doubles, so does the vehicle's momentum. If the weight or the speed triples, so does the momentum.

In short, as speed increases, so does the likelihood of damage in case

of a collision. The lighter your car, the greater the likelihood that it will be damaged.

Kinetic Energy

All objects in motion have *kinetic energy* as well as momentum. Kinetic energy is the energy of motion. The faster a car moves, the more energy of motion it has.

What does this mean to you as a driver? You need to know that the more energy of motion a car has, the more time and distance it will take to stop.

The faster a car moves, the more energy of motion it has. If a car's speed doubles, its stopping distance increases by an amount equal to the square of the difference in speed.

Here is what kinetic energy and momentum can mean when you are accelerating or braking.

Acceleration Suppose that you drive a station wagon and usually carry one or two passengers and light packages. You are aware of how your car accelerates when you enter an expressway. Now suppose that you are going on a trip with four other

people, and the back of the wagon is fully packed. You have increased the weight of your car. It will not accelerate as quickly. Thus, you will not be able to enter an expressway as quickly as you usually do. You may need to manage time and space differently. You might want to press down more on the accelerator to compensate for the extra weight and wait for a larger gap in traffic before entering the roadway.

Braking Once you are moving on the expressway, the car's momentum and kinetic energy have increased because its weight and speed have been increased. Its stopping distance has also increased. Reduce risk by leaving a greater distance between your car and the one in front of you.

Gravity

If you toss a ball into the air, it comes down. The ball falls because of *gravity*. Gravity is a force that pulls all objects toward the center of the Earth. Because gravity affects all objects, it can make a car speed up or slow down.



Don't overload your car. Every 100 miles that you travel with extra weight costs you 1 mile per gallon.



It's a mathematical fact that the faster you drive, the more the braking distance increases.

Use the following formula to demonstrate this. If S is the speed, the formula is:

$$(S \times \frac{1}{10} S) \div 2 = \text{braking distance in feet}$$

Braking distance at a speed of 50 miles per hour can be calculated as:

$$(50 \times 5) \div 2 \\ 250 \div 2 = 125 \text{ feet}$$

You don't have to do the calculations as you drive to realize that the faster you are traveling, the more space you have to leave in front of you in case you have to brake suddenly.

An overpacked car-top carrier can make a car less stable by changing its center of gravity. ▶



WHAT WOULD YOU DO?

What would you say to the passengers about wearing safety belts?

When you drive uphill, gravity acts to slow your car. To maintain speed, accelerate just before the car begins to climb the hill. When you drive downhill, gravity acts with your car, so your speed increases. To keep the car from moving too fast, ease up on the accelerator. You may also have to use your brakes or downshift.

Center of Gravity

Gravity gives objects their weight. The weight of an object, such as your car, is distributed evenly about a point. This point is called the object's *center of gravity*.

The lower an object's center of gravity, the more stable the object. Most cars are designed to have a low center of gravity in order to handle well in turns and during quick maneuvers. Changes in a car's center of gravity affect how well the car handles. A car-top carrier loaded with heavy objects raises the car's center of gravity, making it less stable and difficult to control on turns and curves and during sudden changes in braking, acceleration, and direction. Vehicles that have a high center of gravity, such as vans, also have these problems.



CHECKPOINT

1. What affects traction? How?

Natural laws affect stopping distance, braking, and steering. Understanding the relationships between natural laws and driving can help you to be a better and a safer driver.

How Do Natural Laws Influence Braking Distance?

The laws of nature affect all vehicles the same way, but people react differently. Thus, you may not stop within the same distance another driver in the same car will. The distance your car takes to stop is its *total stopping distance*. Perception distance, reaction distance, plus braking distance make up total stopping distance. A good rule of thumb for estimating stopping distance is to use the 2- or 4-second rule. See Chapter 10 for more information.

In order to stop, you must (1) identify a need to stop (this is your *perception distance*), (2) react by braking (your *reaction distance*), and (3) slow your car to a stop (your *braking distance*). Each of these actions takes time. Time means distance, and speed affects your stopping distance.

Natural Laws and Braking

Braking is a result of friction between the brake linings and the wheel drums or wheel discs and pads. This friction slows the rotation of the wheels and tires and increases adhesion between the tires and the

road. As you brake, you decrease your car's momentum and kinetic energy.

Factors Affecting Braking Distance

The following factors can increase braking distance.

Speed The greater the speed, the longer the braking distance.

Condition of the vehicle Worn brakes, tires, or shock absorbers reduce traction. Reduced traction increases braking distance.

Condition of the roadway Braking distance is greater when the friction on the roadway surface is reduced, such as during bad weather or if the road is unpaved or rough.

Hills and mountains Gravity affects the time and space needed to stop a car going downhill. Because a car going downhill tends to go faster, the braking distance increases.

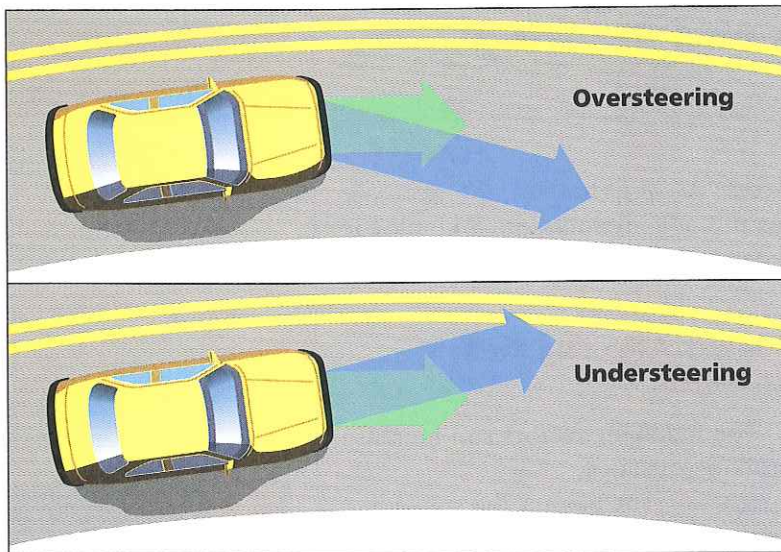
What Factors and Natural Laws Affect Steering?

Your ability to steer a car depends on many factors. The steering mechanism, tires, and suspension are three mechanical factors. Wheel alignment and road conditions are also important in steering, as is the way you load the car.

Friction helps to keep your car on the road. As you know, the friction between the road and tires is usually called traction. When a driver turns



Telephone poles usually are 100 feet apart. Use this measure to help you estimate distance while you are driving.

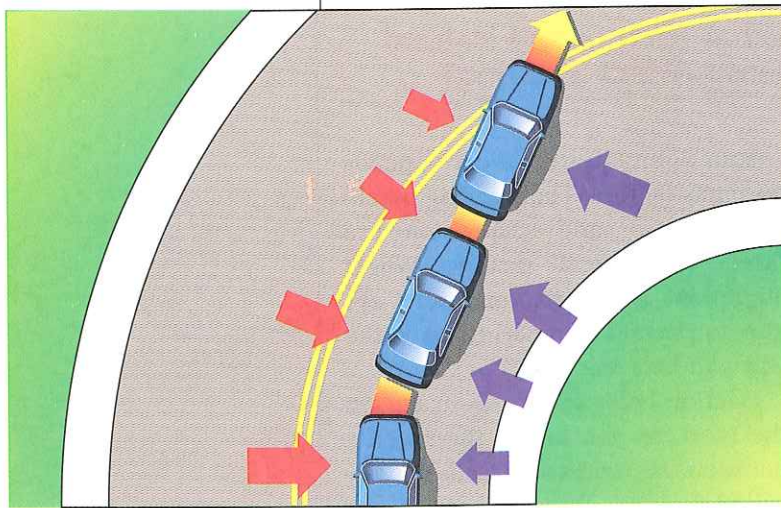


▲ Monitor your speed as you enter a curve so that you neither oversteer nor understeer.

Turning the steering wheel enables friction to overcome centrifugal force.

the steering wheel, the front tires provide the traction to turn the car.

Because of inertia, a moving car will tend to go in a straight line. Because cars and roads are all different, the car may tend to wander. Thus, you must be able to steer straight. *Directional control* refers to a car's ability to hold a straight line. If your car has good directional control, you will have an easy time keeping the car moving in the direction you steer it.



Hand position is another factor that affects car control. Hold the steering wheel firmly, but with your fingers rather than the palms of your hands. Keep your thumbs along the face of the steering wheel, not wrapped around it. This gives a more sensitive touch and better control. Adjust your seat so your hands rest in a balanced position on opposite sides of the wheel.

How Do Natural Laws Affect Steering Around a Curve?

Inertia tends to keep a car moving in a straight path. As you enter a curve or turn, you must overcome the effects of inertia by turning the steering wheel. You are moving the car out of its straight path. At the same time, you feel as if you are being pulled toward the door into the curve. What you feel is *centrifugal force*.

As you slow down and enter the curve or turn, you turn the wheel. Friction between the tires and the road acts against centrifugal force and allows the car to follow a curved path. As long as there is enough friction to overcome centrifugal force, you can make the turn. As you turn the wheel, the front tires provide the traction needed to turn the car.

Slow your car as you enter a curve or turn. The faster you go, the more difficult it is for traction to overcome inertia.

If your speed is too high or you turn the steering wheel too sharply or not enough when entering a curve, you may understeer or oversteer. If you understeer on right

turns or curves, you may find yourself driving in the opposite lane, facing oncoming traffic. If you oversteer, you can pull the car entirely off the roadway. The opposite results are true on left turns or curves.

How Do Gravity and the Contour of the Road Affect Steering?

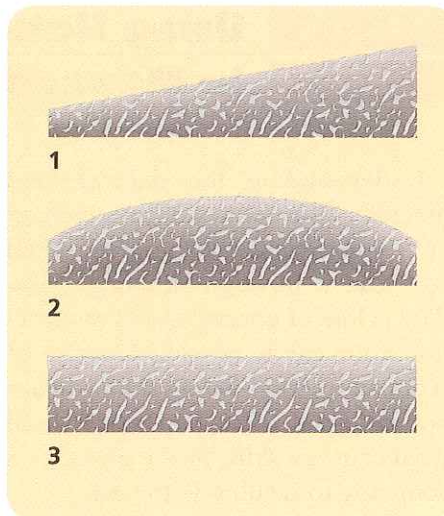
Gravity in relation to the contour of the road affects how well a car will take a curve.

Banked Roads

Have you ever seen the Indy 500 auto race? The track is *banked*, or higher on the outside of curves than on the inside. On a properly banked curve, the roadway tilts down toward the inside of the curve. Although a car tends to move toward the outside of a curve, the downward tilt of a banked curve improves steering control by working with the force of gravity. If the banking or downward tilt was toward the outside of the curve, gravity and inertia would tend to pull the car off the road, making steering more difficult.

Crowned Roads

Crowned roads are higher in the center than at either of the edges to facilitate drainage. When driving in the right lane on a two-way crowned road, gravity will tend to pull your car to the right, off the roadway. You must counteract the effect of gravitational pull by exerting more force on the steering wheel to keep the car on the road.



◀ A car handles differently on (1) banked roads, (2) crowned roads, and (3) flat roads.

CHECKPOINT

2. How do speed, traction, and gravity affect braking distance?
3. Describe how steering is affected by traction and inertia.
4. What role do friction and centrifugal force play in steering around a curve?
5. How does gravity affect steering on a banked or crowned road? How should you respond?



WHAT WOULD YOU DO?

You are driving at 30 mph. Explain what you would do before you enter the curve.



Understanding the natural laws that affect the control of your car can help you regain that control when you lose it through skidding. *Skidding* is loss of control over the direction your car is moving because of reduced traction. If you skid, you are not helpless. Once you understand what causes a skid, you're already on your way to dealing with one.

gerous even for experienced drivers. When traction is reduced, your tires lose their grip on the road's surface and the car begins to slide. Drivers should always be aware of conditions that could result in reduced traction. See Chapter 11 for more information on driving in conditions of reduced traction.

SAFETY TIPS

When driving on slick roads, make gradual and smooth changes in speed. When you want to stop, ease off the accelerator and shift to neutral gear. Press the brake pedal down gently. In neutral, all four wheels brake equally, since none is receiving power. So, traction is increased overall and so is braking efficiency.

What Can Make Your Car Skid?

Whenever you skid, one of three things happened: traction was reduced, you tried to change speed too quickly or you changed direction too quickly.

Reduced Traction

A loss of traction or a reduction in traction can be frightening and dan-

Changing Speed Too Quickly

You are on a slippery road and you want to slow down. You step firmly on the brake pedal and your car starts to skid. What happened? You tried to change speed too quickly. Traction could not overcome the car's kinetic energy and momentum as fast as you wanted it to.

Changing Direction Too Quickly

Turning a car quickly is like a large football player trying to make a sharp turn at a full gallop. Sometimes it works, but sometimes it doesn't. If you're driving at a high speed, your car has a tremendous amount of momentum and kinetic energy. Inertia is also at work, trying to force your car to move in a straight path. Tire traction may not be great enough to compensate for momentum, kinetic energy, and inertia when you turn or enter a sharp curve.

How fast is a high speed? It depends on the road. Look at the speed limit signs posted just below the warning signs as you near a curve. They tell you the maximum safe



Tips for New Drivers

Dealing with Skids

Skidding can be frightening. You can minimize trouble, however, by remembering the following points.

- The most important thing you must do is respond quickly and correctly. Concentrate. Do not panic.
- Do not brake. This will only make the skid worse.
- Look and steer in the direction you want to go.
- Make steering corrections quickly but smoothly.
- Don't give up. Keep steering.

speed you should use to enter the curve. Then you need to adjust speed downward according to conditions.

What Are the Kinds of Skids?

Knowing the kind of skid you are experiencing will help you to manage the risk involved, and may even help you to prevent skidding.

There are four basic kinds of skids: braking, power, cornering, and blowout. If you know the causes and re-

sults of these kinds of skids, and the conditions under which they occur, you can deal with them safely.

◆ A *braking skid* occurs when you apply the brakes so hard that one or more of the wheels lock.

◆ A *power skid* occurs when you suddenly press on the accelerator too hard.

◆ A *cornering skid* occurs when you lose steering control in a turn.

◆ In a *blowout skid*, a tire suddenly loses air pressure.

KINDS OF SKIDS				
Type	Braking skid	Power skid	Cornering skid	Blowout skid
Reason	The brakes are applied so hard that one or more wheels lock.	The gas pedal is pressed suddenly, too hard.	The tires lose traction in a turn.	A tire suddenly loses air pressure.
Conditions	a sudden stop a wet, slippery, or uneven road	a sudden, hard acceleration a slippery road surface	a turn made too fast poor tires or a slippery road surface	a punctured, worn, or overinflated tire an overloaded vehicle
What Can Happen	Steering control is lost. If the front wheels lock, the car skids straight ahead. If only the rear wheels lock, they slide sideways. The car might spin around.	A car with front-wheel drive plows straight ahead. In a car with rear-wheel drive, the back end can skid to the side. The car might spin around.	Steering control is lost. The rear wheels skid away from the turn. The car keeps going straight ahead.	There is a strong pull toward the side on which a front tire has blown out. A rear-tire blowout might cause a pull toward the blowout, side-to-side swaying, or fishtailing.
What To Do	Take your foot off the brake pedal. Steer. When the wheels start turning again and moving forward, steering control will return.	Ease up on the gas pedal until the wheels stop spinning. Steer to straighten the car. Countersteer if the car starts to spin.	Take your foot all the way off the accelerator. Steer to straighten the car.	Do not brake. Make firm, steady steering corrections. Do not change speed suddenly. Slow down gradually and drive off the road.

Accelerate and brake gradually to reduce the risk of skidding on snowy roadways. ▶



WHAT WOULD YOU DO?

You have a blowout. What is likely to happen? What should you do? Why?

How Do You Respond to a Skid?

Suppose you are driving carefully on an ice-covered roadway. There are cars parked alongside the traffic lane, and traffic is heavy in both directions.

Suddenly your car begins to skid. How can you manage the risk of a skid and drive out of it?

1. If you have time, ease off the gas pedal and shift into Neutral. Stay off the brake.
2. With your foot off the pedals, steer in the direction you want the car to go.
3. Each time the skid changes direction, turn the wheel smoothly and quickly in the direction you want the car to go.
4. Keep steering until you are out of the skid.



CHECKPOINT

6. What conditions can make your car skid?
7. Describe four kinds of skids.
8. Describe how to safely steer out of a skid.

The goal of any driver is to avoid collisions and injuries. Good drivers understand how to use accelerating, braking, and steering to help them achieve this goal.

How Can You Use Speed Control to Avoid a Collision?

Braking is a natural reaction to avoid a collision. However, it is not always the correct evasive action.

Accelerating

Speeding up may sometimes be your only means of reducing risk. Such situations occur most often at intersections or in merging traffic. For example, a car may be coming at you rapidly from one side or the other. Braking may leave you directly in the car's path. Steering to the side may take too long or may be impossible if there are objects on both sides of you. If the road ahead is clear, a quick burst of speed may take you to safety, or at least move the crash farther back on the car.

Braking

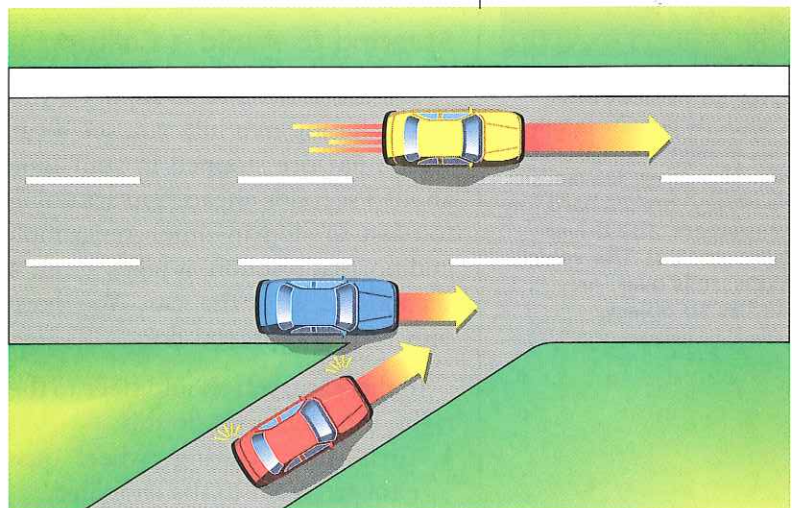
In some situations, steering to the side or accelerating may not be possible. At speeds under 25 mph, it takes less time and distance to stop than to steer into another lane.

When braking, you want to stop fast without making the wheels lock,

or stop turning. Locking the wheels reduces traction and increases stopping distance. To brake quickly, use the threshold/squeeze braking method. With this method, you use your entire body to sense how the brakes are working. Keep your heel on the floor and your foot on the brake so that the metatarsal joint just above the ball of the foot rests on the brake pedal. "Squeeze" the pedal down with a steady, firm pressure until just before the brakes lock. If they lock, ease up about 2 or 3 degrees. Immediately squeeze down again, but not as firmly. Continue until you reach your desired speed. This type of braking allows you to maintain steering control.

The *antilock brake system (ABS)* is optional equipment that eliminates the problem of locked brakes. This system's sensors detect if a wheel stops turning. If this happens, pressure on the wheel's brakes is reduced

The driver in the left lane accelerated to avoid the possible collision in the right lane.



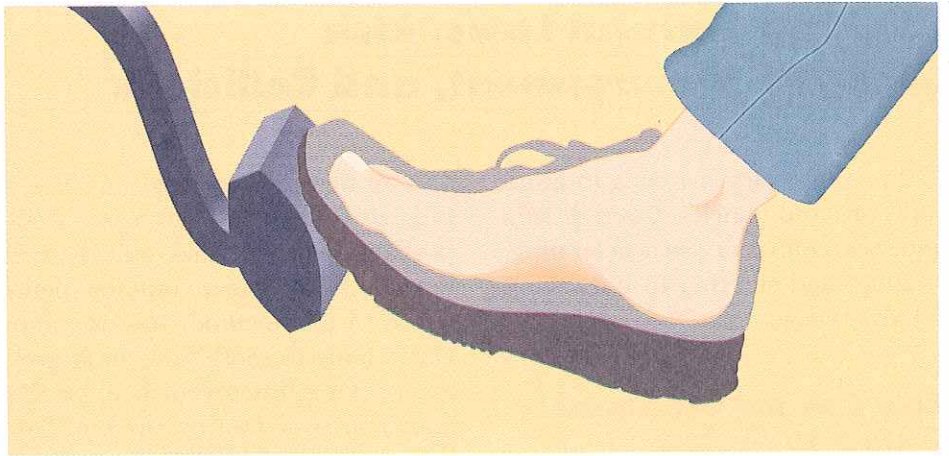
For best braking control, squeeze the brake pedal with your toes. ▶

SAFETY TIPS

When you are making a left turn across oncoming traffic, do not turn your steering wheel to the left until the traffic clears. If you did turn the wheel and then were bumped from behind, you could be pushed into a head-on collision with traffic in the oncoming lane.

FYI

Over 50 percent of all vehicle occupant fatalities involve a single vehicle. The driver leaves the roadway, brakes hard, or oversteers. The driver loses control. The vehicle skids, rolls over, or strikes an object.



until the wheel starts turning again. This action is independent of the pressure the driver applies to the brake pedal. Antilock brakes permit maximum brake pressure while retaining steering control. Do not pump these brakes.

How Can Knowledge of Natural Laws Help You to Avoid a Collision?

A knowledge of natural laws is vital to car control. Knowing how natural laws work is also important when making evasive maneuvers.

Steering to Avoid a Collision

You are driving at 55 mph. As you reach the top of a hill, you see a car with a flat tire stopped in your lane about 3 seconds ahead. You are going too fast to stop in time. At 55 mph and normal traction, it takes about 4 seconds to stop the car. You have only 3. What can you do?

In this case, you should steer to the right, if possible. To do this:

1. Turn the steering wheel just enough to get to the shoulder.

2. Immediately turn it back about twice the amount you turned it to the right.

3. Turn the wheel right to bring the car back into its original path.

You use what you know about traction to steer out of trouble. If you turn the wheel more than half a turn, your speed might be too high for traction to overcome centrifugal force.

Controlled Off-Road Recovery

You see a car that is passing a bus coming toward you. The car will not return to its lane in time. You steer to the right. The car passes on the left, but now your two right wheels are on the unpaved shoulder. You want to get back on the road.

Tires rolling on different surfaces have different amounts of grip. The tires on the paved area have more traction than those on the unpaved area. Applying the brakes may cause the car to skid. Turning the wheel sharply could cause your car to skid, flip over, or shoot back across the roadway. Do this:

1. Let the car move right until the

wheels on the shoulder are about 12 to 18 inches from the road edge.

2. Look for a spot where the edge appears to be no more than 2 inches higher than the shoulder.
3. Check for oncoming and following traffic. Signal your intention to return to the roadway.
4. Move the steering wheel $\frac{1}{8}$ turn to the left. As soon as you feel the right front tire contact the road edge, steer back to the right about half a turn.
5. Immediately turn the steering wheel straight ahead. Do this without braking or accelerating.

This maneuver is called *controlled off-road recovery*.

How Can You Minimize the Risk and Consequences of a Collision?

Unfortunately, it is not always possible to avoid a collision. By knowing what to do before a collision happens, however, you will help to minimize its effects. You should understand the factors that contribute to the force of impact of a collision.

Force of Impact

The force with which a moving car hits another object is called the *force of impact*. Three factors affect the force of impact.

Speed of the car The force of impact at 20 mph is four times that at 10 mph. And the force of impact at 30 mph is nine times that at 10 mph.

Weight of the car The heavier a car is, the harder it will hit any other object.

Impact distance The force of impact also depends on the distance a moving vehicle travels between first impact with an object and the point where the vehicle comes to a full stop. When a car hits an unmoving solid object, the impact distance is short. The object does not “cave in” at impact, and so kinetic energy is spent immediately on impact. The shorter the impact distance, the greater the damage.

Reducing the Force of Impact

You reduce the force of impact if you increase the impact distance. The following energy-absorbing features help increase impact distance.

Sand canisters You often see canisters filled with sand in front of concrete barriers on highways. If a car hits these canisters, they break apart. The sand helps reduce the car’s force of impact. The car would slow more gradually than if it hit the concrete barrier.

Car features New cars include a number of features that help increase impact distance by absorbing energy. These features include air bags; crumple zones; automatic safety belts; head restraints; energy-absorbing bumpers, steering columns, and wheels; padded dashboards; safety-glass windshields; and reinforced sides. See Chapter 6 for more information about energy-absorbing features.

If a Collision Is Unavoidable

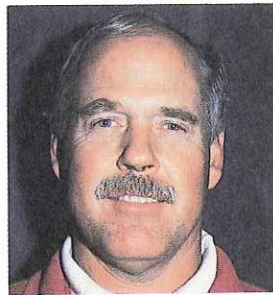
Suppose a collision seems unavoidable. What should you do? If you can increase the impact distance, you will lessen the force of impact, which



In the 1400s, the Inca Empire stretched from the border of Colombia-Ecuador to central Chile in South America. From Cuzco, the capital, well-constructed roads ran to all parts of the empire. The total length of this road system was about 9,500 miles, and was designed for people on foot. Relay runners were stationed at posts along the road to carry messages and parcels quickly to and from the capital.

Advice From the Experts

Bruce Reichel, Driving Instructor, Bill Scott Racing (BSR), Inc.



Bruce Reichel

If you understand the factors involved when a vehicle is in motion, you can learn how to adjust the speed and position of the vehicle to work with the natural laws.

Controlling a car is controlling its energy, and its weight and speed determine the car's energy. A car weighing 2,000 pounds traveling at 30 mph has half the energy of a 4,000-pound car traveling at the same speed. A 2,000-pound car traveling at 60 mph has four times the energy of the same car traveling at 30 mph.



WHAT WOULD YOU DO?

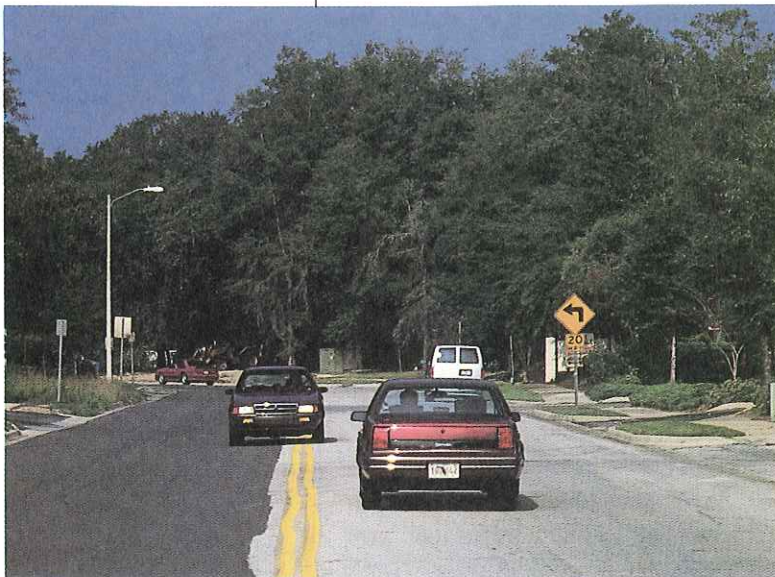
A car has lost control and is swerving into your lane. What should you do?

in turn will reduce the risk of serious damage or injury.

Head-on A head-on collision with another vehicle or an immovable object, such as a large tree, is the worst type of collision. If you can reduce your speed, the force of impact will

be less. Driving into something that is movable, such as a bush or a snowbank, will also reduce the force of impact.

Side Suppose you are about to be broadsided in an intersection and cannot avoid it. How can you minimize the damage? You can accelerate to make impact behind the passenger compartment or with the rear end of your car. This will help minimize damage or injury, since impact will occur behind the passengers.



CHECKPOINT

9. Under what conditions can accelerating or braking help you avoid a collision?
10. How can traction and steering help you avoid a collision?
11. How would you use knowledge of force of impact to respond to a head-on or side collision?

CHAPTER 13 REVIEW

KEY POINTS

LESSON ONE

1. Natural laws include inertia, friction, momentum, kinetic energy, and gravity. Inertia causes objects and passengers in a vehicle to keep moving forward when the vehicle is stopped abruptly. Friction between the road and a car's tires holds the car on the road. Momentum determines the extent of damage in a collision. Kinetic energy affects braking and acceleration. Gravity can slow your car when driving uphill, or increase the speed of a car going downhill.

LESSON TWO

2. Braking is a result of friction between the brake linings and the wheel drums. It slows the rotation of the wheels and tires and increases adhesion between the tires and the road.

3. Friction and inertia affect steering, as do road conditions and a car's tires, steering mechanism, suspension, and wheel alignment.

4. As you enter a curve, inertia and centrifugal force can be overcome by the friction between the tires and roadway.

5. Gravity pulls a car into the curve on an inwardly banked curve, thus improving steering control. If the banking is toward the outer part of the

curve, gravity pulls the car away from the curve, making steering more difficult.

LESSON THREE

6. Reduced traction and too rapid changes in either speed or direction can cause skidding.

7. Four kinds of skids are braking, power, cornering, and blowout.

8. To respond to a skid, do not brake. Look in the direction you want to go. Steer smoothly and quickly in that direction.

LESSON FOUR

9. It is possible to avoid some collisions by accelerating and steering if the roadway is clear. At speeds under 25 mph, braking can help to avoid a collision.

10. You may be able to avoid a collision by understanding the relationship between steering, speed, and friction.

11. Reducing speed, choosing something that will "cave in," and protecting the passenger compartment are three ways to reduce the force of impact and minimize the risk of a collision.

PROJECTS

1. Make a photo display of potential low-traction areas in your community. Label each photo and list the potential danger. If possible, return to the area to check out your suspicion. If you do, make sure to position yourself so you are safe and will not become a danger to traffic.

2. Check the shoulders and off-road areas of some local highways. Are they well designed and maintained? Do they provide an escape path in an emergency? What dangers do they pose to drivers? How do you think they could be improved?

CHAPTER 13 REVIEW

BUILDING MAP SKILLS

Using the Distance Numbers

The distance numbers shown on a map can give you a more accurate idea than the map scale of how far apart two places are. On this map, distance numbers are either black or red. The numbers indicate the distance in miles between towns, junctions, and interchanges.

Here's an example of how the numbers work. Find Lake Butler and Starke on the road map. Along the highway running between the two cities, you'll see a black number 15 (just to the right of the Highway 100 symbol). This means that Lake Butler and Starke are 15 miles apart.

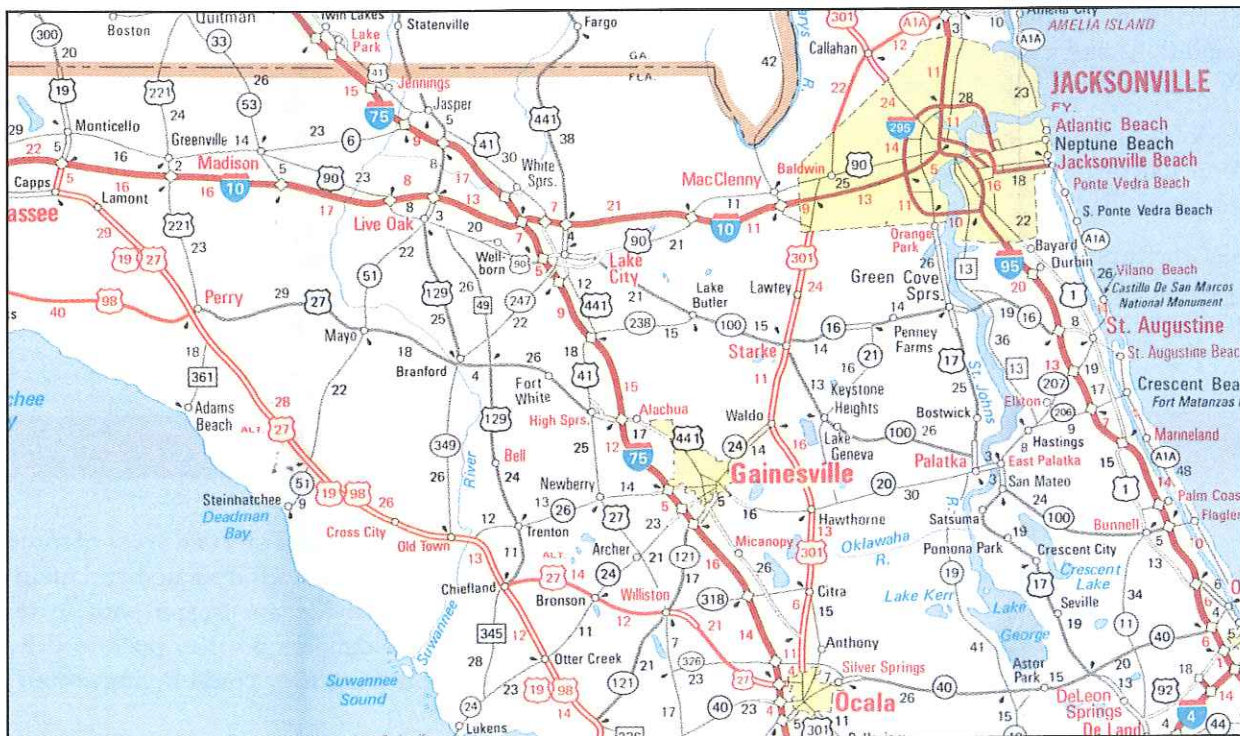
Along Interstate 301 between Starke and Waldo, you'll see the red number 11. It tells you that it's about 11 miles from Starke to Waldo.

If you add the numbers—15 + 11—the sum is 26. So, the distance by road from Lake Butler to Waldo, going through Starke, is about 26 miles.

In general, you can estimate driving time more accurately by using distance numbers rather than the map scale, especially if the road to be driven has many curves and loops. Keep in mind, though, that distance numbers indicate only the mileage, not the condition of the road. Six miles of travel along a twisting back road can take twice as long as ten miles of highway driving!

Try It Yourself

1. How many miles is it from Otter Creek to Trenton along Highways 98 and 129?
2. You're going from Jasper to Branford along Highway 129. How far is it?
3. What is the shortest route going from Greenville to Branford?



CHAPTER 13 REVIEW

CHAPTER TEST

Write the letter of the answer that best completes each sentence.

1. A vehicle's momentum depends on its
 - a. kinetic energy.
 - b. speed and weight.
 - c. center of gravity.
2. If only the outer edges of a tire grip the road,
 - a. the tire is properly inflated.
 - b. the tire is overinflated.
 - c. the tire is underinflated.
3. Three factors that affect braking distance are
 - a. car condition, roadway condition, and speed.
 - b. steering ability, centrifugal force, and ocular tracking.
 - c. tread depth, controlled recovery, and the motion of energy.
4. One way to get out of a skid is to
 - a. look for a patch of wet leaves to slow you down.
 - b. keep your foot off the pedals and steer in the direction you want the car to go.
 - c. slam on the brakes.
5. If your car has good directional control, then
 - a. you can decrease total stopping distance by 3 seconds.
 - b. you will be able to keep the car moving in the direction you steer it.
 - c. you can make sharp turns at high speed.
6. After driving through a deep puddle, it is wise to
 - a. only use engine braking for a while.
 - b. apply light pressure to the brake pedal.
 - c. stop at the nearest service station for brake fluid.

7. A power skid occurs when you
 - a. apply the brakes too hard.
 - b. press the accelerator too hard.
 - c. downshift too quickly.
8. A driver can turn successfully as long as there is enough
 - a. friction to overcome centrifugal force.
 - b. centrifugal force to overcome friction.
 - c. adhesion to overcome friction.
9. Because of inertia,
 - a. objects at rest move in a straight line.
 - b. moving objects continue to move in a straight line.
 - c. moving objects continue to move along a curved path.
10. A car's speed and weight both affect
 - a. the center of gravity.
 - b. friction.
 - c. force of impact.

Write the word or phrase that best completes each sentence.

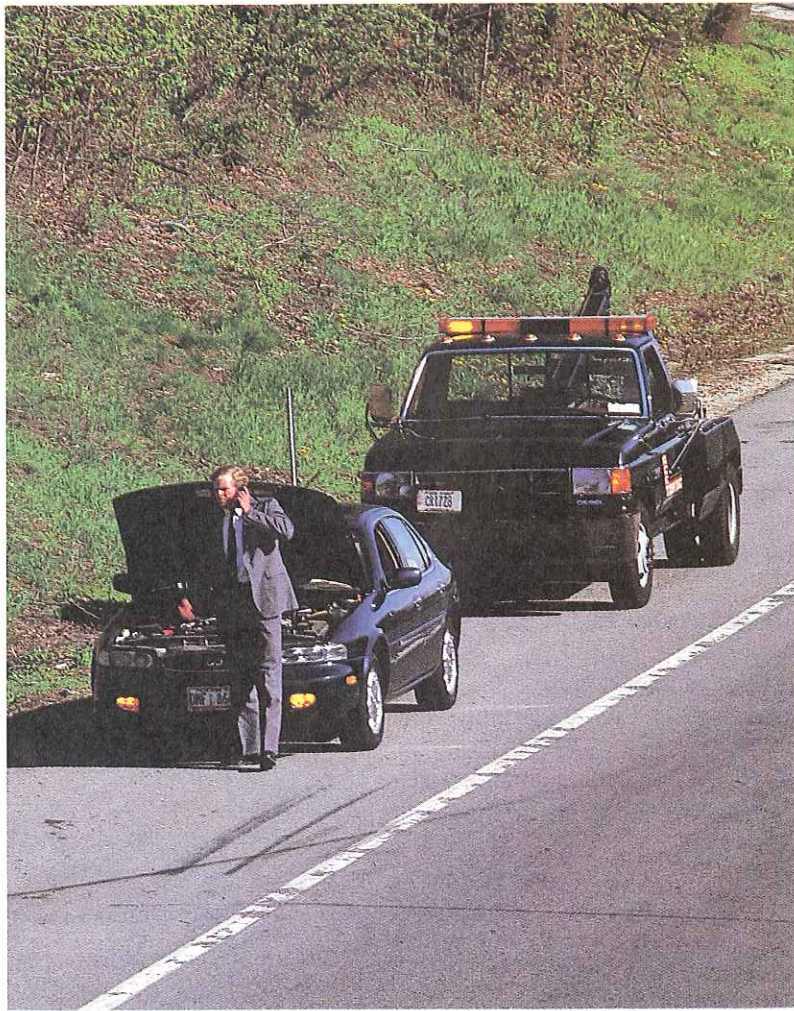
kinetic energy antilock skidding
centripedal inertia center of gravity

11. Any object in motion has _____.
12. Safety belts work against _____ to keep you from being thrown forward.
13. A higher _____ makes a car less stable and harder to control on turns and curves.
14. _____ is loss of control over the direction your car is moving because of reduced traction.
15. _____ brakes permit maximum brake pressure without a loss of steering control.

DRIVER'S LOG

In this chapter, you have learned about the effect that natural laws have on a variety of driving situations. Summarize, in a few sentences for

each, the meaning of inertia, gravity, and momentum. Explain how these laws help you to anticipate and manage risk.



CHAPTER ♦ 14

RESPONDING TO AN EMERGENCY

Emergencies happen even to the most experienced and careful drivers. It is important to learn how to assess and handle emergencies safely, efficiently, and calmly. When you can do this, an emergency may not turn into a disaster.