NATIONAL CAPITAL CHAPTER
BMW CAR CLUB OF AMERICA
WASHINGTON, D.C.

DRIVERS SCHOOL

Introduction to High-Performance Driving

Welcome to the National Capital Chapter's drivers' school program. Our drivers' schools are designed to teach you the techniques of high-performance driving and give you valuable skills that you can apply directly to your daily driving. The goal of our program is to produce the most highly proficient drivers possible.

This introduction is your first lesson. It presents the purpose of the school, explains techniques that you'll learn, and defines terms that we'll use in discussing high-performance driving. Please read it carefully.

There will be no "final exam" at the end of the school. We hope that you will never be faced with a final exam, but if you are, it will happen somewhere on the public roads, where you'll have to make quick maneuvers to avoid a disaster. Should that situation occur, we hope that what you learn at the drivers' school will help you get through it unscathed.

Purpose

We conduct our drivers' schools for two reasons. Our primary objective is to teach you the skills necessary to control your car under all possible conditions. To that end, we want you to discover and understand your car's behavior under a variety of circumstances. This is vitally important should you ever need to call upon your skills in an emergency on the track or on the highway. If you're like most of us, you'll find that your effectiveness in controlling your car is limited initially by your skills rather than your car's capabilities. Modern cars are particularly well adapted to holding the road, and you'll find that your car's limits of adhesion are quite beyond what you had imagined. However, those limits are finite; when you do exceed them, you're likely to be traveling at high speed and therefore to have minimal time to react. That's why we're going to focus on building your skills faster than you build your speed.

Your first few sessions on the track are designed to show you how your car reacts to your inputs (acceleration, braking, and steering). You'll find that *how* you drive has a large effect on how your car behaves. You'll also find that *where* you drive on the track, i.e., the path you choose to drive as your car negotiates a curve, directly affects how fast and how safely you can take that curve.

Later in the school, you'll be able to apply the skills you've learned as you drive the track at higher speeds. Summit Point, like most "road courses," contains examples of many of the conditions you encounter on public roads—left- and right-hand curves of different radii, uphill and downhill stretches, and changing pavement.

The secondary purpose of the school is to give you a chance to enjoy driving your car under controlled conditions. You'll be able to exercise your newly developed skills in ways you cannot do on the street. You're likely to find, as we have, that precision driving is a lot of fun. As a by-product, you'll have much more confidence in your driving abilities at the end of the event, and you'll be a much better street driver as well.

One thing that our drivers' school will not teach you is how to race. *There will be no racing at any National Capital Chapter drivers' school.* If you try to race at the drivers' school, your school experience will be over, as we won't let you back on the track. You should feel no affront to your pride if another car passes you; in fact, you should help him or her get around you. Your sole concern in driving the track is to practice putting your car at precisely the right spot to negotiate the curves, not to beat another car to the next corner.

It's important to realize that no one drivers' school will teach you everything you need to know to become a superlative driver. Acquiring driving skills is a process which typically spans several years and dozens of schools. While it is easy to gain confidence quickly, recognize that overconfidence coupled with high speeds can lead to trouble. Don't rush yourself; plan for the long term and pace yourself throughout the school.

Driving Theory

You've probably lost control of your car at some point in time. Perhaps it was raining or snowing; you entered a curve a little too fast, turned the wheel, but your car kept going straight ahead. Or maybe you had to jam on your brakes suddenly and hope that you'd stop before hitting the car in front of you. In any case, you know that helpless feeling of being "along for the ride" with no control over what's happening.

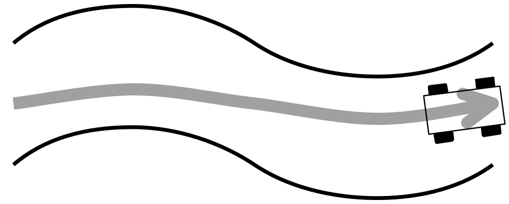
What went wrong, of course, was that you asked your car to do something it couldn't do, either negotiate a curve at too high a speed or come to a stop in too short a distance. Physical laws govern the behavior of your car, and understanding those laws is the key to controlling your car. At the drivers' school, we'll show you—and let you experience—the physical limits of your car's ability to turn or stop. Most importantly, by experiencing and understanding these limits, you'll know what options you have in an emergency.

Curves

Fundamentally, driving is all about friction: specifically, the friction between your tires and the pavement. When you depress the accelerator, or the brake pedal, or turn the steering wheel, your tires generate frictional forces which are applied to your car to accelerate, decelerate, or change directions. Each specific demand you make on your car (turning a corner, for example) requires a certain amount of force. If your tires cannot generate sufficient frictional force, your car will not do what you command.

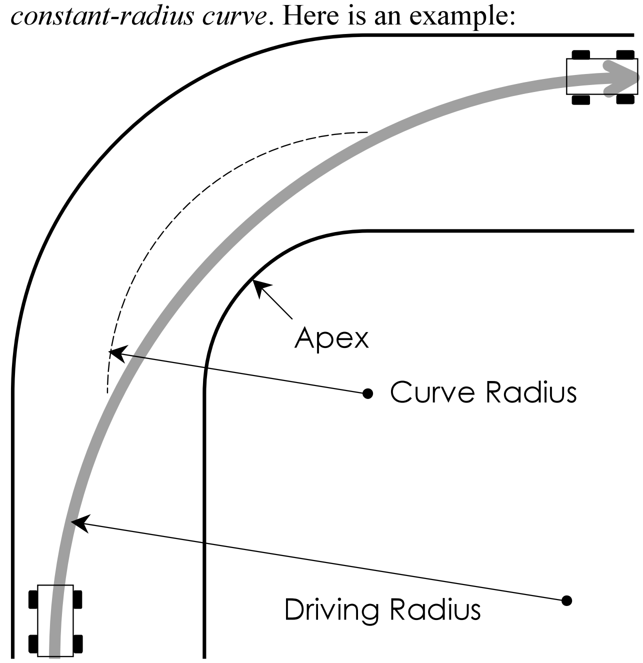
Consider the series of curves below (called an "S curve"). If you follow the shape of the curve, your path will be something like this:

However, if you "straighten out" the curve (called *apexing* the curve), your path will be like this:



Your car requires the least amount of friction with the pavement when traveling in a straight line at a constant speed. Accelerating, braking, or turning require more friction, with larger speed or direction changes (e.g., braking harder or turning sharper) requiring correspondingly larger amounts of friction. Because you are ultimately limited by the friction available, you can go faster (or have a larger safety margin at a given speed) if you lessen your car's frictional requirements. Apexing a curve reduces the friction required by reducing the amount you are turning.

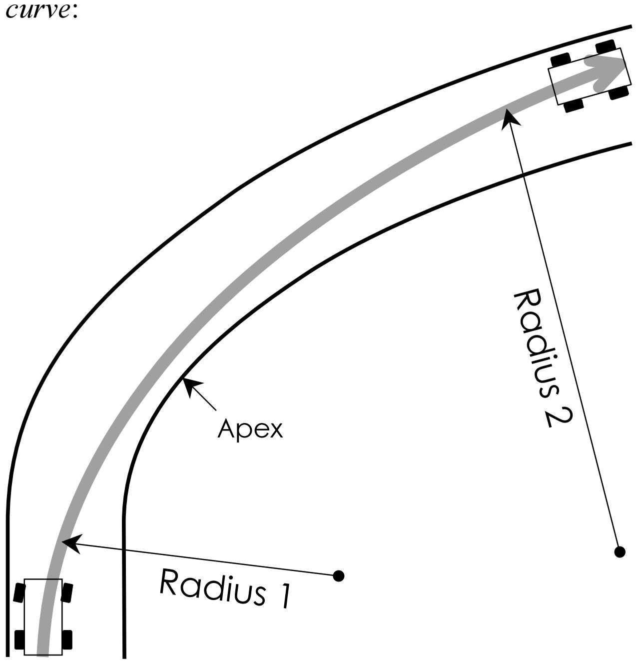
Every curve follows part of the circumference of one or more circles, and the *radius* is the distance from the center of the circle to the curve itself. A curve that follows the circumference of just one circle is called a *constant-radius curve*. Here is an example:



Note two things about this curve. First, the radius remains constant throughout the curve, and the *apex*—the point at which the path your car takes comes closest to the inside of the curve—is halfway through the curve. Second, the *driving radius* is larger than the *curve radius*; this is a consequence of apexing the curve. Turn

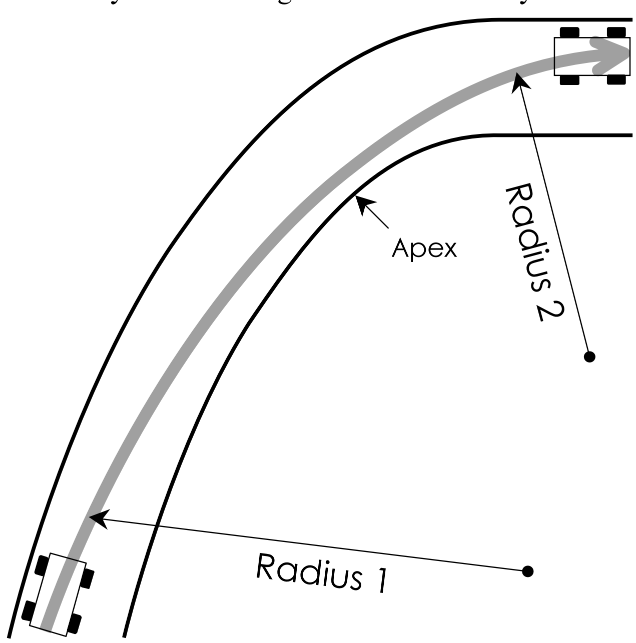
3 at the Summit Point Main Circuit is an example of a constant-radius curve (a curve on a track is called a *turn* or a *corner*).

Another type of curve is the *increasing-radius curve*:



Here, the radius of the curve as you enter it is smaller than the radius of the curve as you exit. The apex occurs earlier in the curve. The Summit Point Main Circuit's Turn 1 is an increasing-radius curve.

There's also a *decreasing-radius curve*, where the radius as you enter is larger than the radius as you leave:



The apex of a decreasing-radius curve occurs later in the curve. When run clockwise, the Summit Point Jefferson Circuit's Turn 4 is an example of a decreasing-radius curve.

We've mentioned an *S curve*, which is a curve in one direction followed by a curve in the opposite direction, forming the shape of the letter S. At the Summit Point Main Circuit, Turns 7-9 form a pair of S curves, as do Turns 1-3 at the Jefferson Circuit.

We'll use some standard terms in talking about curves. The *braking point* is the point at which you begin to slow your car down enough to negotiate the curve. The *turn-in point* (or *entry point*) is where you turn your steering wheel to begin the curve. The *entrance* is the path you take from the turn-in point to the apex. The *apex* is the point of your closest approach to the inside edge of the road. The *exit* is the path you take from the apex to the *track-out point* (or *exit point*), which is the point at which the curve ends.

The most common error made when negotiating curves is turning the steering wheel before the turn-in point. This results in your car following a path that touches the inside of the road before the proper apex. This error is called an *early apex*. If you do the geometry, you'll see that the track-out point of an early-apex path is off the outside of the paved surface. To avoid running off into the grass, you will have to tighten your path. The earlier in the turn you detect your error and apply correction, the less additional steering will be required to return the track-out point to the pavement.

The opposite error, that of turning the steering wheel after the turn-in point, results in a path that touches the inside of the road after the proper apex; this is a *late apex*. Late apexes are inherently safer, because the path leads to a track-out point inside of the edge of the pavement. Note that a late-apex path is still tighter than a correct apex, so your car is still working harder than it should. You should strive to apex properly, but late-apex errors are better than early-apex ones.

Threshold Braking

In order to negotiate most curves, you'll need to reduce your speed very rapidly while maintaining full control of your car. The quickest way to slow down is called *threshold braking*. This means applying the brakes as hard as possible but just shy of the point where your wheels would "lock up" (i.e., where the wheels stop turning and the car slides). It is difficult to modulate precisely the amount of pressure you apply to the brake pedal, and it's even tougher if you're trying to turn the car at the same time. However, if you brake with the ball of your foot, you'll have a lot more control.

If your car is equipped with an antilock braking system (ABS), you can always just mash down on the brake pedal and let the ABS do all of the work for you. However, true threshold braking, i.e., applying maximal braking just *before* the ABS kicks in, will result in slightly shorter braking distances. Therefore, you should learn and practice threshold braking by modulating the pedal pressure to keep the ABS from activating.

Handling

Two important aspects of your car's handling are *balance* and *weight transfer*. Balance is how your car's weight is distributed from front to rear and from side to side. The weight of your car generates proportional frictional forces (i.e., *grip*) at each tire, and these forces change profoundly when you accelerate, decelerate, or change direction; this is called weight transfer.

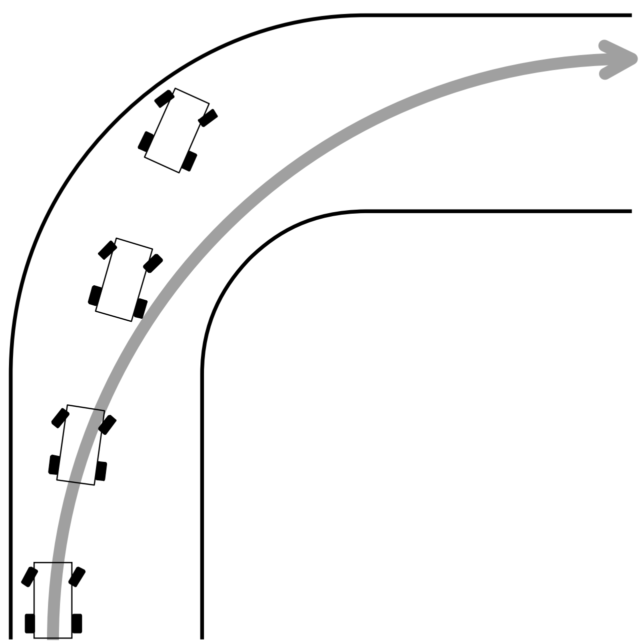
When you accelerate, weight transfers to the rear of your car, decreasing the grip available to your front tires and increasing the grip available to your rear tires. When you decelerate, weight transfers to the front of your car, enhancing front tire grip and decreasing rear tire grip. In a turn, weight transfers to the outer tires, reducing the grip of your inner tires. The amount by which grip changes at each tire in response to weight transfer is determined primarily by your car's suspension and its reactions to your inputs.

For a given corner taken at a given speed, each of your tires requires a certain amount of grip to maintain adhesion with the pavement. Higher speeds and tighter corners require correspondingly more grip. If weight transfer causes the grip available at a given tire to decrease below that which is required, it will lose adhesion and begin to slide against the pavement. If the sliding tire is at the front of your car, your car will *understeer*; if it is at the rear, your car will *oversteer*.

Understeer, also called "push" or "plough," occurs when your front tires lose adhesion with the pavement. Instead of following your intended path around the turn, your car will begin to run wide, as though you were steering less than you needed to. Understeer is often caused by entering a turn too fast or by turning the steering wheel too quickly: both upset the balance of your car.

The important thing to realize is that understeer occurs because your front tires are overloaded; they require more grip to maintain adhesion than is available. Steering more, i.e., trying to turn a tighter arc, simply overloads them more, making the understeer worse. To correct understeer, you must restore adhesion to the front tires by slowing your car and/or straightening the steering wheel; both reduce the grip required. Straightening the wheel is counterintuitive, because you're deliberately steering toward the outside edge of the pavement, but you *must* regain front-end adhesion before you can change your car's direction.

Oversteer, or "looseness," occurs when your rear tires lose adhesion with the pavement. Instead of following your intended path around the turn, your car will begin to rotate around your front tires, as though you were steering more than you needed to. To stop the rotation of your car around its front wheels, you must apply a countering force by steering toward the outside of the turn. You must also maintain your speed or accelerate slightly. This too is counterintuitive, because

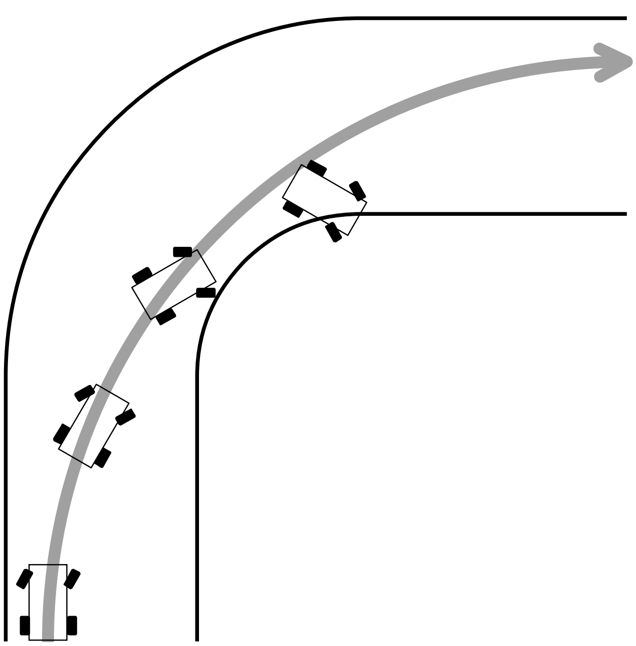


In "terminal understeer," the front wheels lose traction, and the car continues going straight ahead.

the last thing you'll think you need at that point is more speed. However, when you accelerate, you transfer weight back onto your rear tires, giving them more grip. It's important to recognize here that you're applying acceleration not to increase your speed, but to restore your car's balance.

Oversteer is often caused by sudden deceleration in a turn, either by braking or by coming sharply off the accelerator, causing weight to transfer away from the rear wheels. This often occurs when you enter a turn too fast; the solution is to enter more slowly, so that you can maintain your car's balance throughout the turn.

Oversteer in a rear-wheel drive car can also be caused by applying enough acceleration to break the rear wheels loose. This occurs most frequently under conditions of reduced adhesion (rain), but it can also occur under good conditions if your car is powerful enough. In this case, you must reduce your acceleration *slightly* to allow your rear tires to re-adhere. If you reduce your acceleration too much or too rapidly, weight will transfer away from the rear, and your car will continue to oversteer. To avoid inducing oversteer, it's important to apply acceleration smoothly and progressively. Remember: anything you do to upset your car's balance may transfer enough weight to cause understeer or oversteer. That's why we will emphasize *smoothness* throughout your school.



In "terminal oversteer," the car's rear wheels lose traction and cause the car to spin.

If you experience *terminal understeer* or *terminal oversteer* (the "terminal" in this case doesn't mean "fatal," but rather "uncorrectable"), and you're going to go off the track, **do not** try to force your car to stay on the track. Instead, straighten your steering wheel and drive off the track under as much control as you can manage. It is far more important to maintain control than it is to stay on the paved surface.

Where to Look

Whenever you're driving, you should watch *where you're going.* This seems to be obvious, but you'd be surprised how much time you spend looking at where you are—at your hood or at the bumper of the car in front of you, for instance. On the track, as on the Interstate, things happen with great rapidity at high speeds. To avoid problems, you must have as much advance warning of potential trouble as possible, and that means *looking as far ahead as possible*. By doing so, you will be able to anticipate trouble and thereby keep yourself safe.

As you become familiar with the track and its turns, you'll naturally develop reference points to guide you around the track. Initially, you'll find yourself concentrating very hard on these reference points: look at the braking point, look at the turn-in point, look at the apex, and so on. Chances are, you'll still be looking at the turn-in point as you begin to turn the car. The technique to develop is to look at where you want to go, not at where you are. This is called *ocular driving*. If you look ahead, you'll find your driving becomes much smoother, and with smoothness comes both safety and speed.

Speed, in and of itself, is not dangerous. You may be in more danger driving 30 MPH on a foggy two-lane road at night than driving 70 MPH on the Interstate on a clear, sunny day. Increasing speed does, however, reduce your available reaction time. That's why it's *crucial* to extend that time as much as possible by looking as far ahead as possible, consistent with driving accurately. The faster you go, the farther ahead you must look to maintain the same safety margin.

After you've mastered looking ahead, the next technique to master is enlarging your field of vision. If you're looking ahead at the apex, you probably won't see the flagger off to your right. If you're concentrating on the next braking point, you may not notice the car overtaking in your rear-view mirror. By expanding your field of vision, you'll find you are much more aware of all your surroundings—not just the next reference point, but the next two or three reference points. Again, this will make your driving smoother. In addition, if you're taking in more than just the next braking point, you may notice the car in front of you getting loose in the turn, or you may notice the sheen of oil at the turn entry, thereby knowing that you need to do something immediately in order to avoid disaster.

Putting It All Together

When you're driving the track at Summit Point—and anytime you're driving rapidly and skillfully—you need to combine your knowledge of cornering, braking, and accelerating into a smooth, flowing process. If you concentrate on and practice driving smoothly, speed will follow naturally. If your actions are abrupt, and you try to force your unbalanced car into corners, you'll find it very frustrating and difficult to develop any sense of rhythm. You will also never develop any speed.

What follows are brief discussions of some of the techniques you'll be taught at the drivers' school. If you practice these driving techniques, you'll find that driving fast is comfortable and enjoyable.

Ocular driving—Look where you want your car to go, rather than where your car is now. If you're entering a turn, look at the apex. If you're at the apex, look at the exit. If you're driving down a straightaway, look well ahead toward the next turn. If you do this, you'll find that you automatically steer the car toward where you want it to go. You'll also find that your inputs are much smoother, as your brain will be registering a larger time context. If you look just at the road immediately in front of you, you won't be prepared for the next turn or obstacle. In addition, it's a good idea to keep an eye on your rear-view mirrors. If you're completely aware of everything that's going on around you, you can avoid surprises.

Braking and downshifting—As you approach a turn, do all of your braking and downshifting while you're still traveling in a straight line. Then, as you enter the turn, you can concentrate on steering the car toward the apex and maintaining the balance of your car throughout the turn. Make sure you've released the clutch before you begin to turn; otherwise, you may unbalance your car.

Entering a turn—As you reach the turn-in point, look to the apex and steer your car toward it. Maintain your car's balance with a light pressure on the accelerator until your car has successfully transitioned into the turn. Your path from the turn-in point should be a smooth arc; if you have to "saw" your steering wheel back and forth, or if you're still on the brakes, then you've entered the turn too fast. Remember that speed into a turn isn't important; balance is. You will exit far more quickly and under far better control if your entry is slow enough to "settle" your car on its suspension immediately after turn-in.

Apexing—As you approach the apex of the turn, look ahead to the track-out point. Start accelerating gently at the apex. If you've entered the turn properly, the car will head toward the exit almost effortlessly.

Exiting—As you approach the exit of the turn, look ahead to the next turn or down the upcoming straightaway. Keep accelerating steadily and begin to steer the car toward your next "mark," as needed.

These techniques aren't the only way to handle your car, but they're a good start. Once you've mastered them, you can move on to more advanced techniques.

End of Lesson One

The most important point to keep in mind is that in order to go fast you must control your car at all times. The less you upset your car, the smoother, safer, and faster you'll be able to go. Remember, it's the laws of physics that determine what your car can and can't do; if you try to break those laws, you'll get caught every time, and the penalty you pay can be very high.

Your classroom and in-car instructors will discuss driving techniques in more detail. If you have questions at any time, please don't hesitate to ask either of them. We understand that you might be embarrassed to ask, but remember that it will aid your learning—and will make our jobs easier—if you ask whenever you are unsure.

Freude am fahren!