Maybe you can answer this

Have a question? Have an answer? Here's where it goes.

Why does water in the sink drain away counter-clockwise—and why should we care?

You will find lots of answers to the first question in textbooks and on educational web sites, but I don't find any of them very convincing. They almost invariably start talking about a thing called a "Coriolis force", in spite of the fact that lots of other textbooks and educational web sites will, quite rightly, explain that there is no such thing. Below is how I think it goes—and I promise, I won't mention "Coriolis" again.

There are either one or two good answers to the second question (why care?) depending on your interest, or lack of it, in golf. But I'll get to that later.

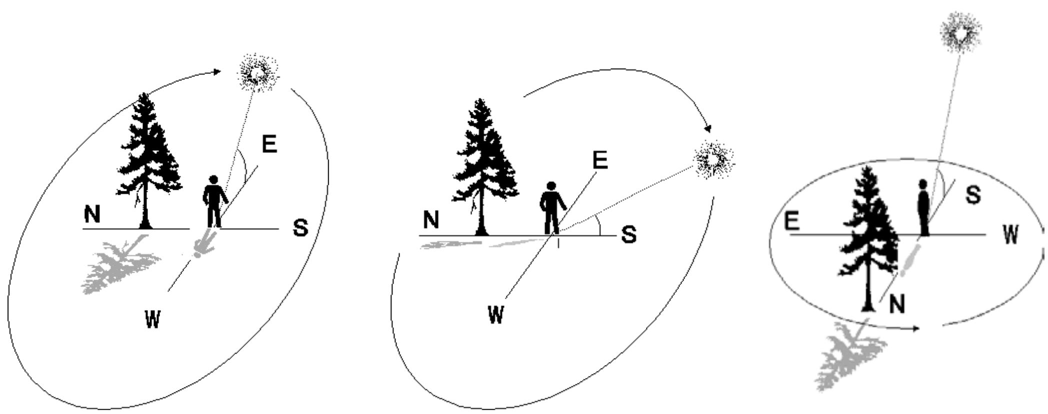
The sink problem

So why does water in a sink rotate counter-clockwise as it drains away? Well, actually of course—it doesn't. The rotational direction of the draining water is determined by the way the sink was filled, the eddies generated while washing, and by the shape of the basin. It's easy to make it go either way—just go try. However, if you were to have:

- a large, perfectly-symmetrical, shallow, circular basin
- with a pinhole-sized drain
- with a plug that opened from beneath instead of on top to avoid disturbing the water when it was pulled
- and you left the water undisturbed for about a week before pulling the plug,

then, anywhere north of the equator, you would indeed always see the water draining away counter-clockwise. South of the equator it would always go clockwise.

Let's start the explanation of the direction of the swirl, not in the bathroom, but out in the yard.

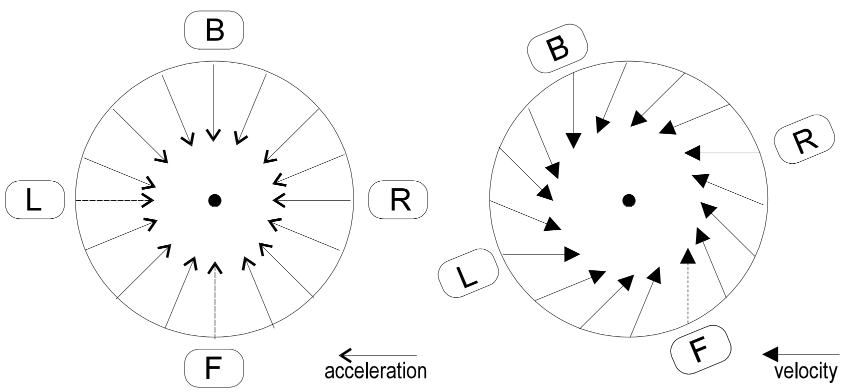


In the picture on the left, a man stands facing the sun in the east at six o'clock in the morning. On his left, to the north, is a tree. Six hours later, at noon, the sun has circled around 90º clockwise to the south. This is shown in the middle picture.

According to everyday common sense, the man hasn't moved; the tree hasn't moved; only the sun has moved. But, we all know that that is not what *really* happened. The sun has hardly changed its position at all. What has really happened is that everything in the picture on the earth's surface has rotated 90º counter-clockwise (picture on the right). If you ignore the upward movement of the rising sun, you can see that the line between the man's yard and the sun has changed direction very little (it actually circles round slowly once every year, but we can ignore that here).

The lesson is this. Because all motion is relative, you can pick any point on the surface of the earth in the northern hemisphere, and once a day everything will seem to rotate counter-clockwise around that point. The pictures show rotation around the man, but we could just as well have drawn the lines to illustrate the man rotating around the tree. It comes to exactly the same thing.

Now, after six hours, let's go to the bathroom—but don't forget to bring this copy of *SHALE* with you!



On the left is a sink with four bars of soap around its edge (sorry, I'm not very good at drawing soap). At the precise moment the plug in the centre is pulled, all of the water will begin to move toward the hole. The arrows show the directions in which the water at the rim of the sink accelerates.

Now some time later (on the right), the sink and its bars of soap have, relative to the sun and stars, rotated counter-clockwise around the drain, just like the tree around the man (or the man around the tree). The arrows now show the velocity of the water.

The water next to the bar of soap marked **F** (first picture) was accelerated up the page, and so its velocity, as seen by an observer in space (second picture), is also up the page. The water next to the bar of soap marked **R** (first picture) was accelerated right to left, and so its velocity, as seen by an observer in space (second picture), remains right to left. And so on.

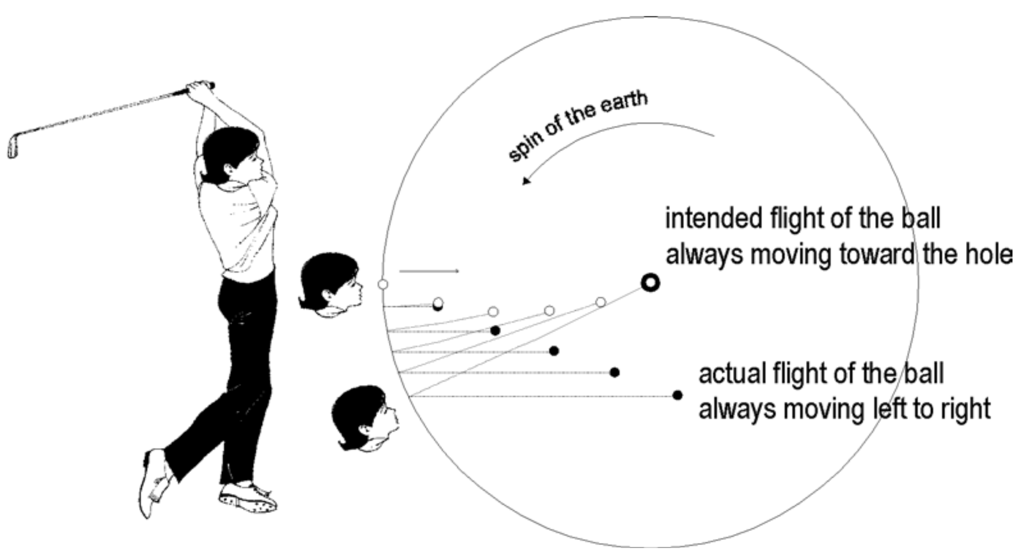
Without further explanation, I hope, you can see the water swirling away—counter-clockwise.

Why should we care?—for golfers

Here's an explanation of why golfers sometimes miss the hole. We have just seen that, in the northern hemisphere, as a result of the earth's rotation, you can consider any point on the surface as being stationary while everything else rotates around it counter-clockwise. In this example, we'll consider the hole as being stationary.

In the picture below, the golfer stands to the left of the hole and so hits it toward the right. As she anxiously watches the flight of the ball, her expectation is that it will always keep moving directly toward the hole (the white ball in the diagram). Now during the few seconds the ball is in the air, the golfer will rotate counter-clockwise at a rate of one revolution per day around the hole. To her of course, it seems as though the sky is rotating, not her, but it isn't so. The distant stars don't move anywhere. The ball however, being up in the air, is unaware of all this; all it knows is that a body in motion will, in the absence of a force, continue to move at a constant speed in a straight line. Since the ball was hit left to right, it continues to move left to right. It will also move top to bottom because that's the way it was moving before it was hit. Hence, to the golfer's annoyance, the ball deviates to the right of its intended path. At the latitude of Gabriola, the deviation to the right for a ball travelling 100 yards in five seconds is, according to my calculations, about an inch (25 millimetres). I don't play golf, so I don't know, but that sounds pretty serious to me.

Contrary to what it says in some textbooks and in some web pages, this deviation to the right applies equally in all directions. The only difference that direction makes is that, because the earth's surface is not the plane of rotation (the equatorial plane), balls hit east will also suffer a vertical deviation and will appear to arrive at the hole, in this example, about one inch (22 millimetres) too high, while those hit west will appear to arrive about one inch too low. You can think of this as the spin of the earth helping propel the ball when you hit it toward the east, which is very useful to know if you are a rocket engineer trying to launch something into space.



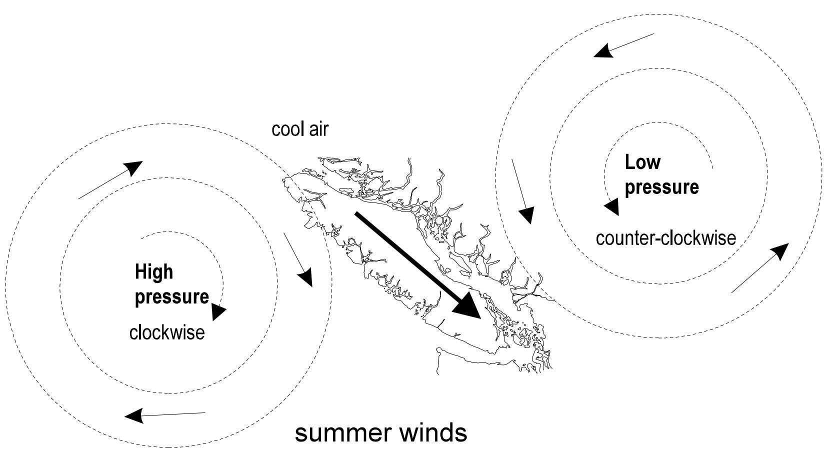
Why should we care?—for people who don't like to shovel snow

Answer two. The Gulf Islands probably have the most benign climate of all Canada. Summers are pleasantly warm—winters are mild. The agent responsible for this moderation is of course the wind. In summer, while much of the rest of southern Canada swelters, cooler air moves down over the islands from the Gulf of Alaska. And in winter, when everyone else is shovelling snow, warm air blows up to us from down south—often from the general direction of Hawaii.

So, what has all this to do with the water draining away in the sink? Well, if the water went down the sink the other way, we'd have a climate like they have in Newfoundland where spring doesn't arrive until May.

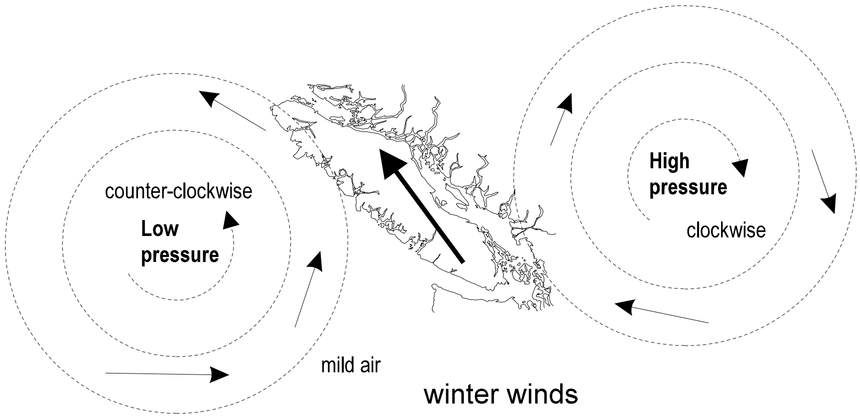
The air around a region of low pressure (a depression or cyclone) circulates around the pressure-centre counter-clockwise for exactly the same reason the draining water does in the sink. The only slight difference is that the water goes *down* the hole, while the warm air converging on the centre of a low-pressure system goes *up*.

Everything is reversed for a high-pressure system (an anticyclone). The air moves clockwise around its centre and cold air descends from above into the centre. We'll have a bit more to say about that later.



In summer, the warm air above the mainland (on the right) expands and becomes more buoyant; it rises creating a low-pressure zone, around which the air moves counter-clockwise. Over the ocean to our west (on the left), the air becomes, relatively, cold and dense. It sinks creating a high-pressure zone. The summer pattern is therefore low pressure to the east; high pressure to the west. The winds circulate around their respective pressure-centres like a pair of rollers, directing the air to us from the north. This flow becomes a "northwester" on Gabriola because the axis of the Strait of Georgia is oriented northwest-southeast, and the mountains either side of the strait guide the surface winds in this direction.

The northwest winds of summer bring cooler air, and because they are cooler, they absorb heat and become less humid as they pass over us—our summers are very dry.



In winter, everything is reversed. The snow-covered continent to the east (on the right) is cold. The denser air sinks creating a high-pressure zone. Over the ocean, the temperature of the sea hasn't changed much since summer and the air is, relatively, warm and light. It rises creating a low-pressure zone—a depression—around which the air circulates, always counter-clockwise. The winter pattern is therefore high pressure to the east; low pressure to the west. Hence, southerly winds. On Gabriola, these are "southeasters", again, because of the northwest-southeast orientation of the strait.

Winter winds that keep us from freezing, cool themselves down as they pass over us, frequently to the point where they no longer retain their moisture, and it rains—our winters, though mild, are very wet.

If the direction of all the arrows were reversed, you can see we'd be in for some very cold winters. So…aren't you very glad the water goes down the sink counter-clockwise, and not the other way round?

Why does air in an anticylcone circulate clockwise?

—shouldn't it just diffuse outward because of the high pressure at the centre?

This is one I've yet to find answered properly anywhere. The question is this. Motion in a circle requires that there be an inward force. In the case of the orbiting earth, the inward force is the sun's gravity. If you swirl a weight attached to a rope round your head, the inward force is provided by your arm muscles. What then is the inward force in an anticyclone where pressure is high at the centre, not low?

Well the answer, I think, is this. The air does *not* circulate clockwise around the centre of an anticyclone. It rotates counter-clockwise, but it does so more slowly than one revolution a day. Because it rotates more slowly than does the earth's surface, the air just *appears* to be going the other way. The high pressure opposes the earth's gravity, thereby slowing down the counter-clockwise rotation, but doesn't overcome it.

There's an interesting corollary to this. At our latitude, an anticyclone can never rotate faster than about ¾ of a revolution per day. That's quite slow and must be part of the reason why high-pressure weather is so benign—the summer of 2002 being a good example. Wind speed is limited and there are no high-pressure equivalents of depressions, hurricanes, tornadoes, and winter storms. And it's all Coriolis free—pretty neat, eh! ◊

NICK DOE