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The effects of speed on the angle of reflection

Think of a laser beam hitting a mirror. In physics the angle of approach is called the angle of *incidence* and the angle of rebound is called the angle of *reflection.* Just as your high school physics teacher told you, these two angles are precisely the same.

Rail Kickback Effect

In pool the principle is the essentially the same, but not exactly so. Strange things happen during the tiny interval from when the ball first meets the cushion until it leaves. The strangeness comes from the depression of the cushion. If the cushion were impenetrably hard, say like granite, the ball would bounce just as predictably as a light beam and Pool would be so much easier. But far less challenging and interesting.

Consider a ball approaching a cushion perpendicularly at high speed. Picture the precise instant when the ball has sunk its deepest into the cushion and is about to begin its outward journey. Using aerospace parlance, this point of the ball's trip into the cushion material is called its *perigee,* a fancy word that means the *lowest (i.e. deepest)* point. At perigee, the cushion has wrapped itself partly around the ball, forming a shallow letter C. The two arms of the C, like the bands of a slingshot, are about to propel the ball outward. Because the ball entered perpendicularly, the C is perfectly symmetrical and so shoots the ball back out perpendicularly, exiting it exactly along the path from which it came.

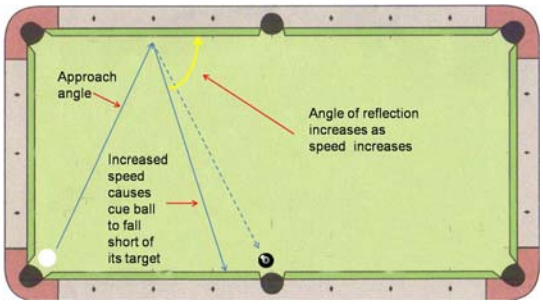
A ball striking a rail perpendicularly leaves perpendicularly regardless of the speed with which it approached. This 90-degree case, which rarely presents itself in a pool game, is the only one for which speed doesn't affect rebound angle. For all other angles, speed does matter. Following is an explanation of why this is so.

We'd like to create a picture in your mind's eye, one you can take with you to the pool hall. Conjure up this image before your next cushion shot and it will help you factor the speed effect into your rebound prediction. It goes like this.

If a ball approaches a cushion at an angle not perpendicular, the C formed at perigee will not be symmetrical. Call the arm that is closer to you, the *assisting* arm because during the rebound it works to push the ball down-rail, along travel direction. Call the arm that is further from you the *opposing* arm, because works to push the ball up-rail, opposite the travel direction. You should instinctively see that the opposing arm wraps itself more fully around the ball than the assisting arm does. It sort of bunches up against the flow of the ball, if you will. You should also see that

this bunching asymmetry increases with increasing ball speed because higher speed means deeper penetration.

If the ball approaches the rail at very low speed, the C depression will be very slight and nearly symmetrical. Rebound angle will very nearly match approach angle. So for very gentle rail touches the ball path approaches the laser path: rebound angle equal to approach angle (angle of reflection equals angle of incidence). As ball speed goes up however, the increased bunching of the C's opposing arm works to push the ball out more and more perpendicularly from the rail. Rebound angle becomes greater and greater than approach angle as speed increases.



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Now the phrase: "Rebound angle increases with ball speed." should longer be one you accept purely out of faith in your pool instructor, but one you understand because you have thought it through. This is the *rail kickback effect: Rebound angle increases with ball speed.*

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