
Note: Narrated video (NV) demonstrations, high-speed video (HSV) clips, and technical proofs (TP) can be accessed and viewed online at www.engr.colostate.edu/pool. The reference numbers used in the article correspond to the numbers used on the website.

In my article last month, I introduced a very important principle of billiards called the 90° rule. It states that when the cue ball strikes an object ball with no topspin or bottom spin the two balls will always separate at 90°, regardless of the cut angle. Put another way, the cue ball will leave along the tangent line, which is perpendicular to the impact line with the ball. Principle 1, NV 3.4, and TP 3.1 summarize and illustrate the important points (see last month's article for more information).

As shown in last month's article (Part I), the 90° rule is very useful for helping to prevent scratches. This month (Part II), we look at how the same rule can also be used to plan break-up and avoidance shots. In next month's article (Part III) we will look at how the 90° rule can be used to plan carom and billiards shots. Hopefully, after this series of articles, you will appreciate how important this rule is, and will be able to use it in your game.

Principle 1 90° rule

With a stun shot where there is no topspin or bottom spin, after impact the cue ball will depart along the tangent line, which is perpendicular (at a right angle) to the impact line. In other words the cue ball and object ball paths, after impact, will be 90° apart (see NV 3.4 and TP 3.1).



normal video

NV 3.4 – 90° rule with various entering angles



technical proof

TP 3.1 – 90° rule

When attempting to “run the table” (i.e., make the entire sequence of balls necessary to win a game), there will be times when you need to break up balls that are tied up and cannot be made easily. These are called **break-up shots**. At other times, you will want to avoid hitting balls that are in favorable locations (e.g., balls set up for easy shots, or balls blocking shots for your opponent). These are called **avoidance shots**. Being able to visualize the tangent line path predicted by the 90° rule is an invaluable skill when planning these types of shots.

Diagram 1 shows a table layout that presents an ideal opportunity for a break-up shot. An inexperienced player might think: “The 2-ball is a *duck* in the pocket, and the cue ball is so close, I should definitely pocket that ball first.” An experienced player would think instead: “I want to win the game by pocketing the four remaining solids and then the 8-ball. To do this, I need to break up the 3-ball and 4-ball. Neither ball can be pocketed easily, if at all, in their current positions. Also, the 2-ball is a good insurance policy in case I need an easy shot to get me out of trouble later, helping me achieve position for another shot. Therefore, I will leave the 2-ball there, pocket the 1-ball first, and break up the 3-ball and 4-ball in the process.” In a shot like this, the 2-ball is called an **insurance ball** because it can be pocketed fairly easily from almost any spot on the table in case you lose control of the cue ball on a previous shot.

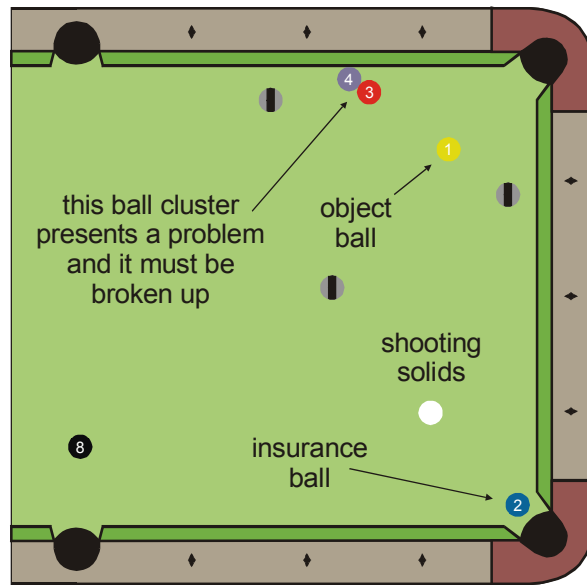


Diagram 1 Example break-up opportunity

Diagram 2 illustrates how the 90° rule is used to plan the break-up shot. Bottom English and medium to fast speed is used to ensure that the cue ball has no spin when it contacts the 1-ball. The cue ball will deflect off the 1-ball and hit the 3-ball fairly squarely causing the 3-ball and 4-ball to separate and rebound off the rail. A possible end result of the shot is shown in **Diagram 3**. The 3-ball and 4-ball are no longer tied up. And more importantly, now the remaining balls can be pocketed with ease, resulting in a victory. As illustrated in **Diagram 4**, the 3-ball is made first, then the 2-ball. After pocketing the 2-ball, the cue ball can be left in good position for a straight-in shot on the 4-ball, resulting in an easy shot on the 8-ball.

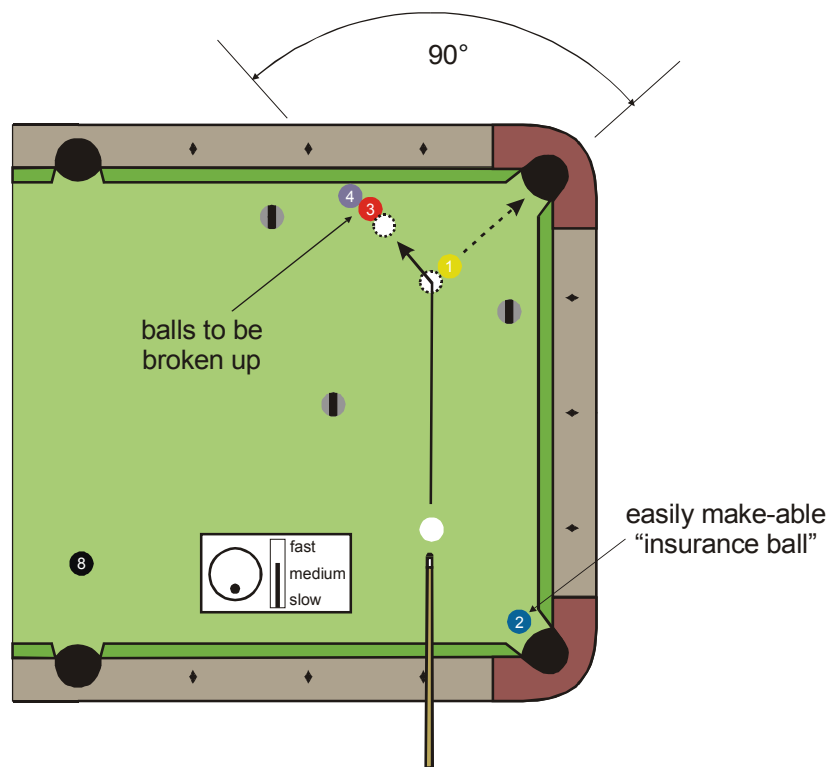


Diagram 2 Using the 90° rule to break up problem balls

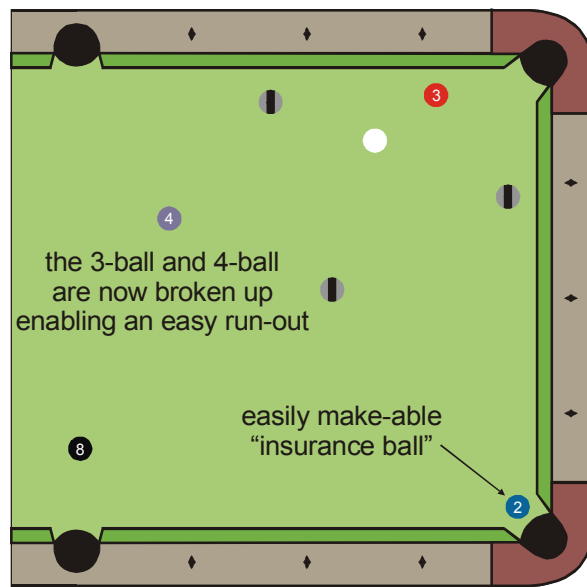


Diagram 3 Possible table layout after a break-up shot

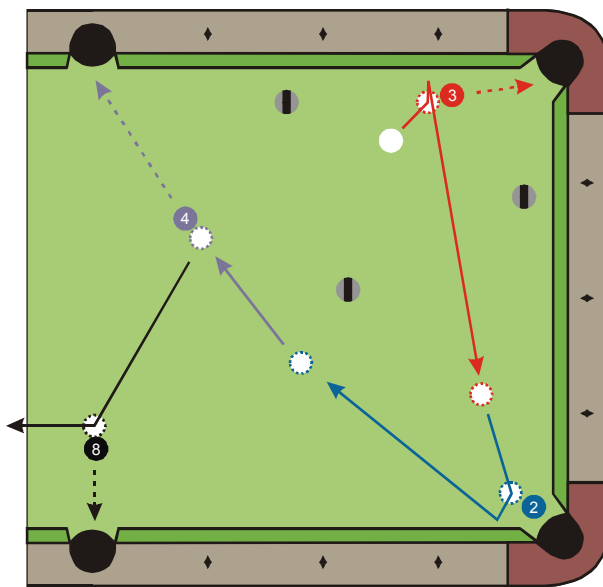


Diagram 4 Running the table after a break-up shot

With a break-up shot, the goal is to purposely drive the cue ball into object balls. With avoidance shots, the goal is to purposely avoid hitting certain balls. In the game of 8-ball, the balls you want to avoid could be your own ("stripes" or "solids") if they already happen to be in good places (e.g., close to a pocket, or blocking shots for you opponent). The balls to avoid could also be your opponent's balls if they happen to be in a bad place for your opponent (e.g., tied up in a cluster). Also, sometimes you just want to avoid hitting balls so the cue ball can end up in good position for your next shot. **Diagram 5** shows a table layout where an avoidance shot is appropriate, assuming you are shooting "solids." The two "stripes" are tied up and you would like to leave them that way so if you do not run the table your opponent will be faced with a difficult shot. You also need to avoid the "stripes" to reliably control the position of the cue ball.

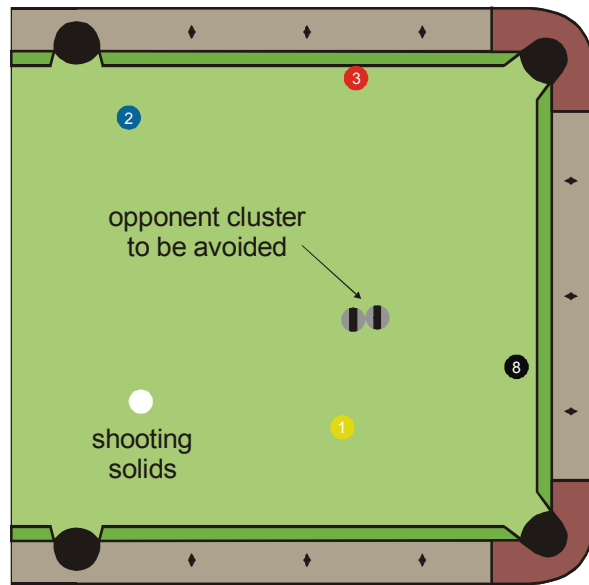


Diagram 5 Example table layout requiring an avoidance shot

Diagram 6 shows how knowledge of the 90° rule tangent line and the effects of English can be used to plan the path of the cue ball, assuming the 1-ball will be pocketed first. Note that the 90° rule predicts that the cue ball would deflect directly into the tied up “stripes.” But remember, the 90° rule only applies exactly in the case of a stun shot, where the cue ball is sliding without topspin or bottom spin. To have the cue ball avoid the “stripe” cluster, you can use a medium speed follow stroke as shown in the diagram. The cue ball will be rolling when it hits the 1-ball and the resulting path will be short of the tangent line (i.e., the resulting angle is less than 90°). The deflected cue ball path leaves the “stripes” undisturbed and results in good position for the 2-ball shot. A principle called the 30° rule, which can be used to predict the exact path of the cue ball, will be presented in a future article. **Diagram 7** shows how the remainder of the table can be run easily, resulting in victory.

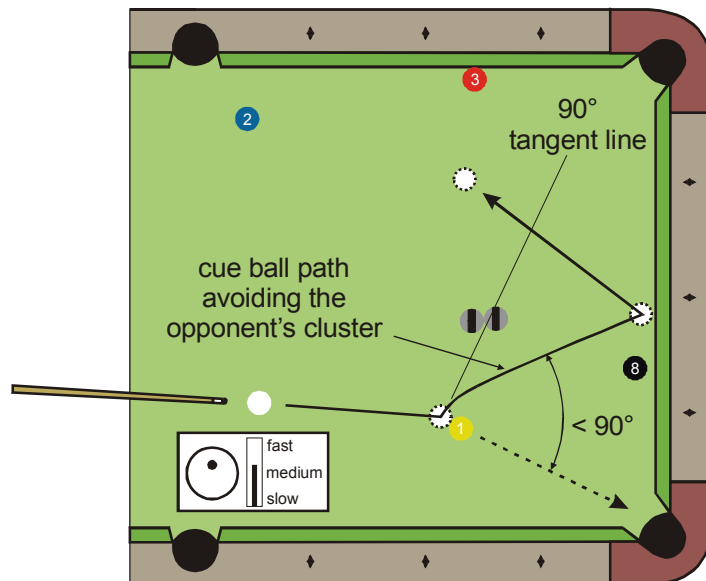


Diagram 6 Using the 30° rule to plan an avoidance shot

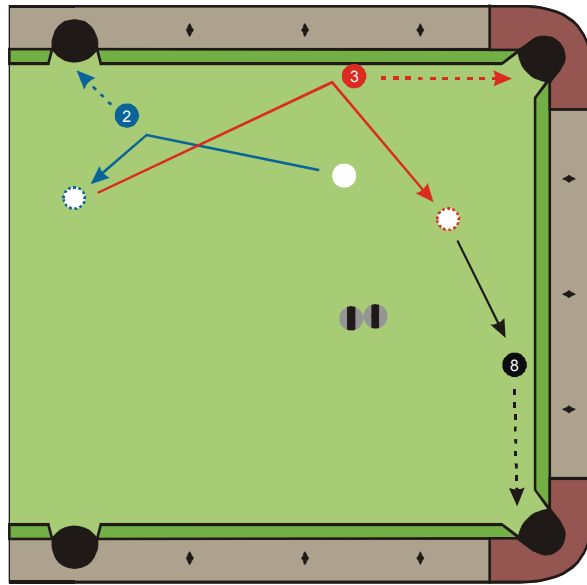


Diagram 7 Running the table after an avoidance shot

I hope that by now, you agree that knowing the 90° rule is a good thing. With experience, you develop intuition for where the cue ball will go after hitting an object ball, but it is still nice to be able to check yourself with the principle. Just in case you still aren't convinced of the value of the 90° rule, I will show some more examples of how it is used in practice next month. Good luck with your game!