

Express Riddler

31 January 2020

Riddle:

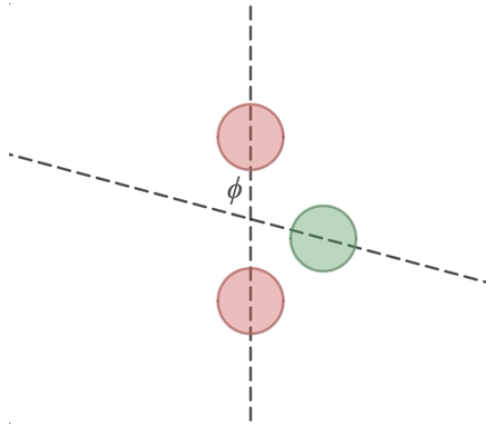
At the recent World Indoor Bowls Championships in Great Yarmouth, England, one of the rolls by Nick Brett went viral. Here it is in all its glory:

[Video link](#)

In order for Nick's green bowl to split the two red bowls, he needed expert precision in both the speed of the roll and its final angle of approach.

Suppose you were standing in Nick's shoes, and you wanted to split two of your opponent's bowls. Let's simplify the math a little, and say that each bowl is a sphere with a radius of 1. Let's further suppose that your opponent's two red bowls are separated by a distance of 3—that is, the centers of the red bowls are separated by a distance of 5. Define ϕ as the angle between the path your bowl is on and the line connecting your opponent's bowls.

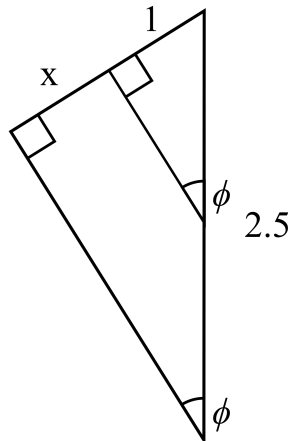
For example, here's how you could split your opponent's bowls when ϕ is 75 degrees:



What is the *minimum* value of ϕ that will allow your bowl to split your opponent's bowls without hitting them?

Solution:

This is a pretty basic geometry problem. I have expanded the above diagram with a few extra labels:



Here, x is half the total width available to your bowl, and the vertical distance is 2.5, which is half the distance between the opponent's bowls' centers. The solution is to solve for ϕ when $x = 1$, which is easy because (as I highlighted) there is a nice right triangle there. I just need to solve $\sin(\phi) = 1+x/2.5$, or $\phi = \sin^{-1}(0.8)$. This gives the solution $\phi \approx 53.13^\circ$.