

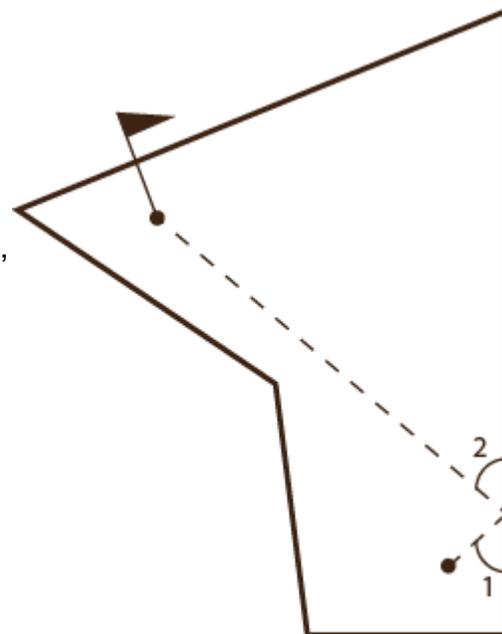
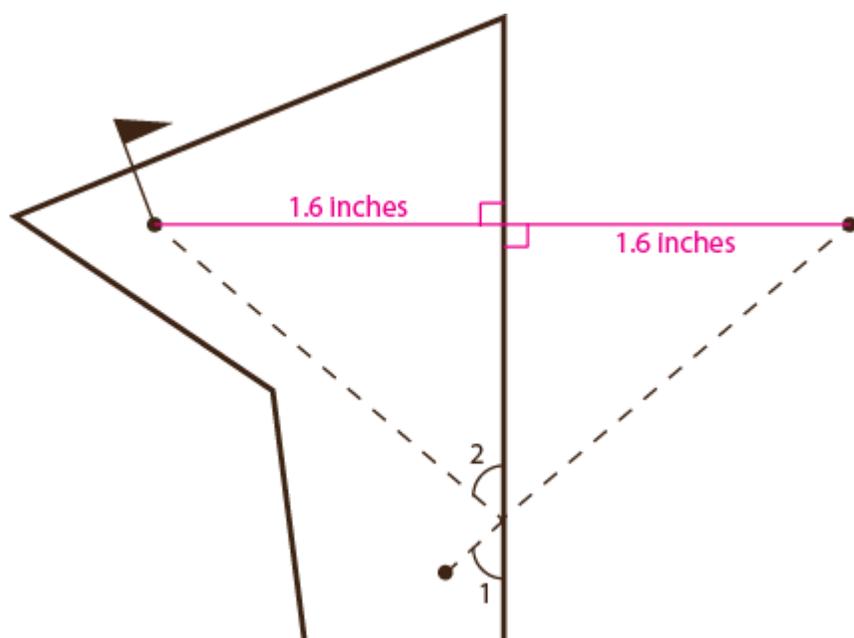
# Unmarred Miniature Golf

While your game may not always prove it, miniature golf is easy – even holes-in-one!

Making a shot is as simple as bouncing your ball off of an outside wall. The trick is the angle at which your ball hits the wall.

In order to make your shot, you always want to bounce your shot off of the wall such that the angle of the initial shot and the wall is the same as the angle of the bounce and the same wall. More simply, angle 1 must equal angle 2.

You could probably take out a protractor and get to work, measuring and moving your line until the angles are equal. Fortunately there is an easier way!



All you need to do is *reflect* the hole over the wall you plan on hitting.

1. Take a ruler and lay it across the wall you want to hit. The ruler needs to be *perpendicular* with the wall, or needs to make 4  $90^\circ$  angles.
2. Measure the distance between the hole and the wall. Double that distance and mark your hole's *image*.
3. Draw a line from the ball to the image of the hole. Stop your line when you meet the wall.
4. Connect this line to the real hole and you have your solution!

What happens if we make things more complicated? If we have to bounce the ball off of 2 walls, we do the same thing, except we start from the end (the hole) and do 2 reflections.

1. Take a ruler and lay it across the wall you want to hit right before the ball makes it to the hole (H). The ruler still needs to be perpendicular with the wall.
2. Measure the distance between the hole (H) and the wall. Double that distance and mark your hole's first image (H').
3. Now take the ruler and make another perpendicular line across the other wall you want to hit. (You may need to extend the wall for this to work.)
4. Measure the distance between the hole's image (H') and the second wall. Double that distance and mark your hole's second image (H'').
5. Now connect the ball with the second image (H''). Connect the bounce point with H'. Connect the second bounce with H. You can check our work by checking for equal angles.

**Your Task:** Cut out the course at the bottom and tape it to a larger piece of paper. See if you can make a hole-in-one using one bounce. Then grab a colored pencil and use two bounces instead!

