

HAMILTON'S MATH TO BUILD ON

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Construction Trades Press • P.O. Box 953
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Cutting Elbows

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▶ Cutting the 90° Elbow into 45° Elbows

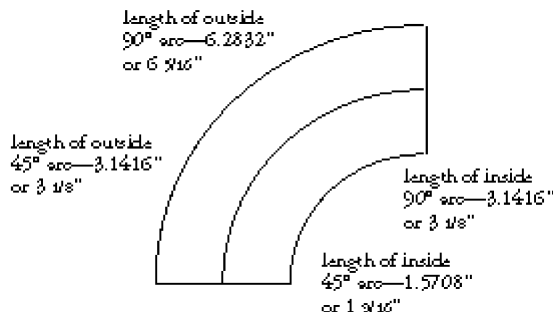
Let's cut one of these 90° elbows into smaller 45° elbows.

A quick division of 90° / 45° shows that two 45° elbows can be created from one 90° elbow. Below you will find three different ways to calculate measurements to mark 45° elbows.

The first method is: Measuring or calculating the inside and outside arc length for the 90° arc and dividing these lengths by two.

90° outside arc length = 6.2832"
45° outside arc length = 6.2832"/2 or 3.1416"
90° inside arc length = 3.1416"
45° inside arc length = 3.1416"/2 or 1.5708"

You can measure and mark the length of the outside arc by either rolling the arc or by using a flexible tape measure. The inside arc will have to be measured using a flexible tape measure.



The second method is: Calculating the inside and outside arc lengths for a 45° elbow and marking and cutting the 90° elbow from these calculations.

Arc length = radius x radian

Outside arc radius = 4"

Outside 45° arc length = 4" x .7854

45° = 45 x 1/4 / 180 = .7854 radians

Outside 45° arc length = 3.1416"

Inside 45° arc length = 2" x .7854

Inside arc radius = 2"

Inside 45° arc length = 1.5708"

The third method is: Finding the length of the outside and inside arcs, dividing these measurements by 90, and multiplying the answers by the degrees (in this case, 45) of the desired elbow.

We have already measured the outside and inside arcs for the 90° elbow.

Outside arc length = 6.2832" and
Inside arc length = 3.1416".

Divide the 90° outside arc by 90, then multiply the answer by 45.

$$6.2832"/90 = .06981333$$

$$.06981333 \times 45 = \mathbf{3.1416"} \quad \text{---}$$

Divide the 90° inside arc by 90, then multiply the answer by 45.

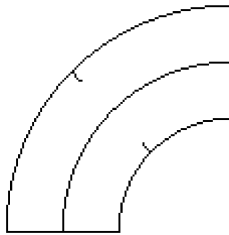
$$3.1416"/90 = .034906666$$

$$.034906666 \times 45 = \mathbf{1.5708"} \quad \text{---}$$

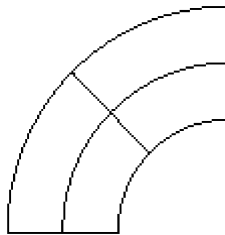
Notice that all methods of calculation provide the same answer.

These calculations are used to mark the 90° elbow. Once the 45° arcs are marked on the 90° elbow, it can be cut to form two 45° elbows.

First: Use the measurements from one of the above calculations to mark the arcs for two 45° elbows.

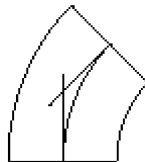


Connect the marks by drawing a line between the two marked points. Cut the elbow at the marked line to make two 45° elbows.

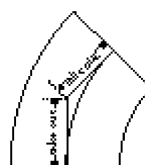


Let's look closely at takeouts for a 45° elbow. **Remember:** The take out of an elbow or bend is calculated based on the center radius.

First: From the center arc on both faces of two 45° elbows, draw perpendicular lines toward the center of the elbow.



The distance from the face of the elbow to the point where the lines meet is the length of the take out.



Here are the calculations for take out for a 3" 45° arc.

$$\begin{aligned} \text{Take out} &= \tan \theta/2 \times \text{radius of turn} \\ \text{Take out} &= \tan 22.5^\circ \times 3" \end{aligned}$$

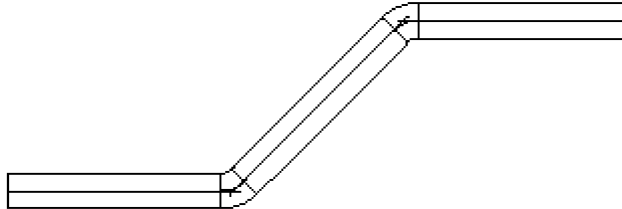
$$\begin{aligned} \text{Center radius} &= 3" \\ \tan 22.5^\circ &= .4142 \end{aligned}$$

$$\text{Take out} = .4142 \times 3"$$

$$\text{Take out} = 1.2426" \quad (1 \frac{1}{4}')$$

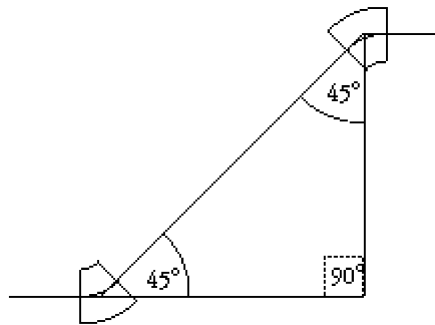
Second: Measure the lines you just drew in. They should measure $1 \frac{1}{4}$ ", the same as the calculations.

Third: Take the one foot straight pieces you cut for the previous exercise and use two 45° elbows to make a 45° simple offset.

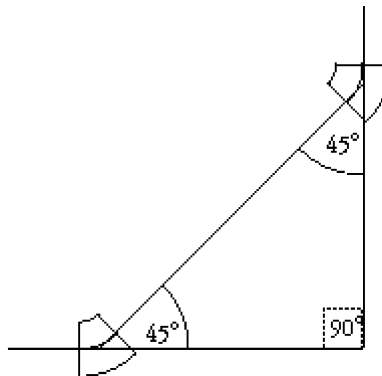


Notice where the offset triangle is in the offset.

The points where the take out lines meet are the vertices of the angles of the offset triangle.



Note: You can turn one of the 45° elbows around to make an offset turn. Again, the vertices of the angles of the offset triangles are the points where the take out lines meet.



You should now be able to draw, cut out, and put together just about anything you need.

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19 September 1995

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