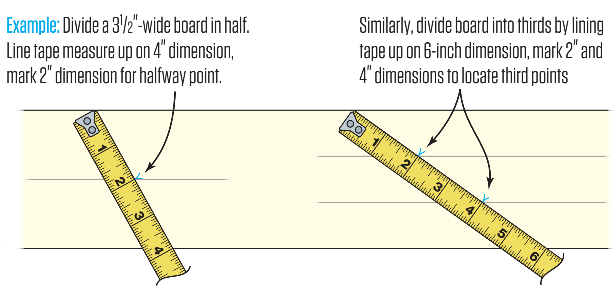
BY JLC STAFF

Geometry for Carpenters

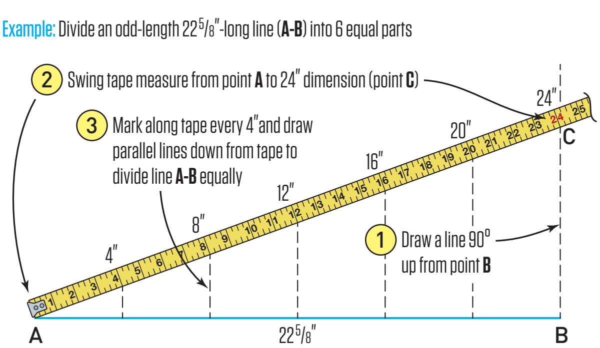
Math is fundamental to building. And while there is no escaping the need to be proficient with numbers and algebra, learning some geometry can go a long way in helping carpenters be more efficient. In this article, we'll introduce a few methods for dividing, measuring, and laying out shapes that can save time and take some of the head scratching out of many layout jobs.

The first principle we'll address is the idea of using a scale of known increments (a tape measure) to divide a line or area. In the first two examples below, we don't need to know the width of the board we want to divide, or make any calculations. We simply hold the end of tape along one edge and run it out to the opposite edge. The distance and angle of the tape don't matter, as long as we align the opposite edge with a number on the tape that we can easily divide by 2 or 3 (or any divisor we want). This same concept can be used to divide an uneven distance into a number of equal segments without having to pull out a calculator. And the idea of marking off even segments can be useful when laying out various curves, as shown in the examples at right.

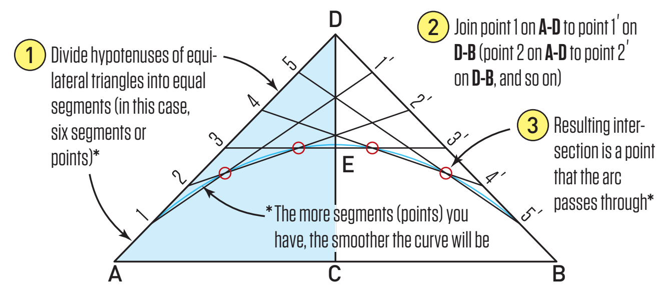
Dividing a Board



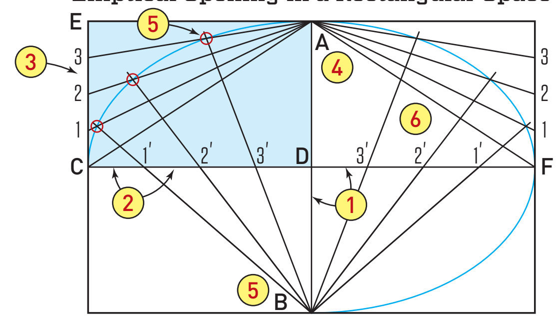
Dividing a Line



Making an Arch (Straight-line Method)

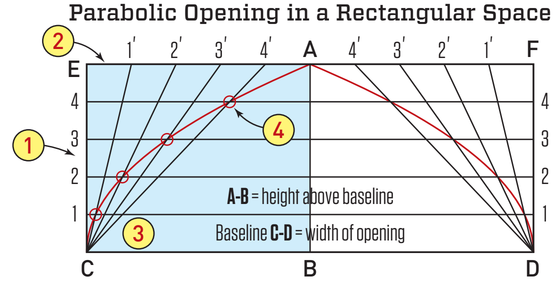


Elliptical Opening in a Rectangular Space



1. Draw the lines **A-B** and **C-F**. **2.** From the center **D**, divide **C-D** into any number of equal segments (say 4) at 1', 2', and 3'. **3.** Divide **C-E** into the same number of equal segments at 1, 2, and 3. **4.** Join point **A** with points 1, 2, and 3. **5.** Join point **B** with points 1', 2', and 3'. The resulting intersections are the points that the ellipse passes through. **6.** Repeat the steps above for each quadrant (only two for an arch, or all four for a full ellipse).

Parabolic Opening in a Rectangular Space



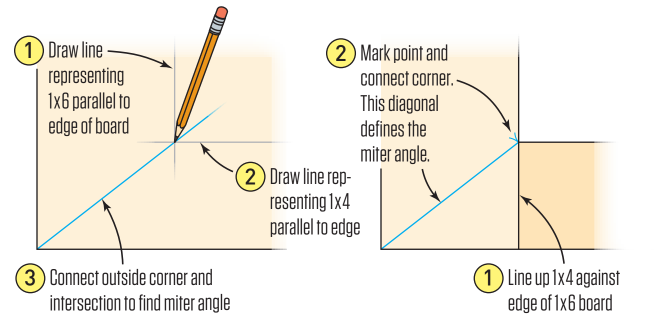
1. Divide the height of the rectangle into equal segments (in this case, 5 segments), and draw parallel horizontal lines dividing the rectangle. **2.** Divide the length of the rectangle in half, and divide each half into the same number of segments as the height. **3.** Project lines from ends of the baseline to each of the points dividing the length of the rectangle (1', 2', and so on). **4.** The intersection of these projections with the parallel divisions of the rectangle define a parabolic curve in each half of the rectangle.

Illustrations by Tim Healey

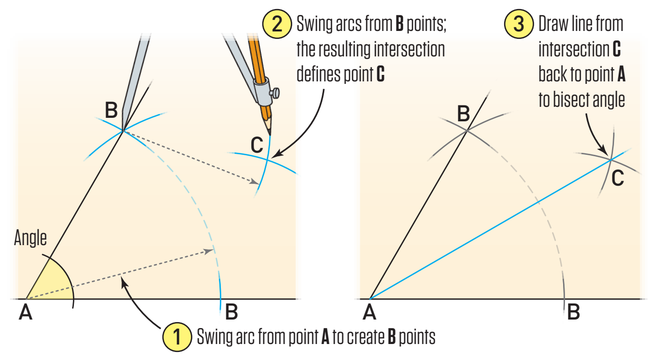
Angles are fundamental to joinery. Most of the time, we are dealing with right angles (90 degrees) and regular miters (45 degrees). What happens when we encounter other angles? Our inclination is to measure that angle in degrees somehow (with an electronic angle finder or a protractor, for example) because the table on a miter saw is set up with degree adjustments. However, a lot of times we don't need to know the numbers. The miter for joining boards of unequal width, for example, is an acute angle less than 45 degrees, which we can lay out using parallel lines, as shown at right. Once we understand this idea, we can just measure the width of one meeting board off the end of the other and join the diagonal.

Or we can lay out any angle using a compass and a straightedge to bisect the angle. If we do this on a scrap piece of wood, we can cut the angle we've drawn by aligning it with the blade on our miter saw—no numbers needed. The same concept of swinging an arc (either with a compass or with a tape measure) can also be used to lay out different shapes, such as a square, a hexagon, or an octagon, as shown below.

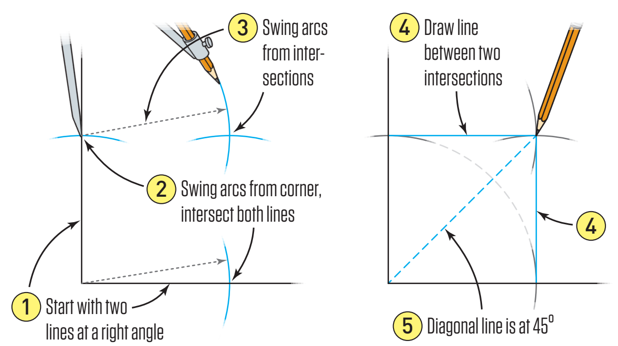
Finding Miter Angle Using Parallel Lines



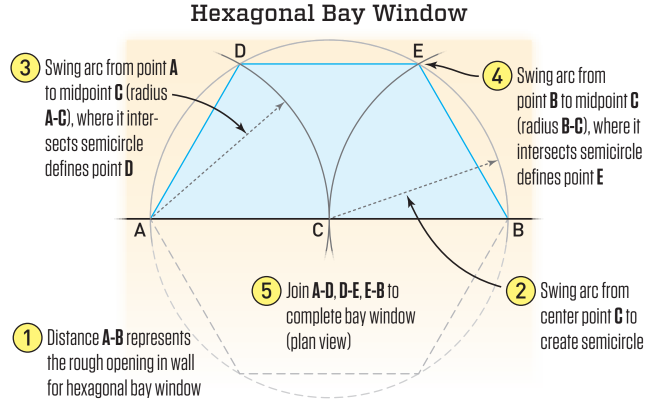
Bisecting an Angle



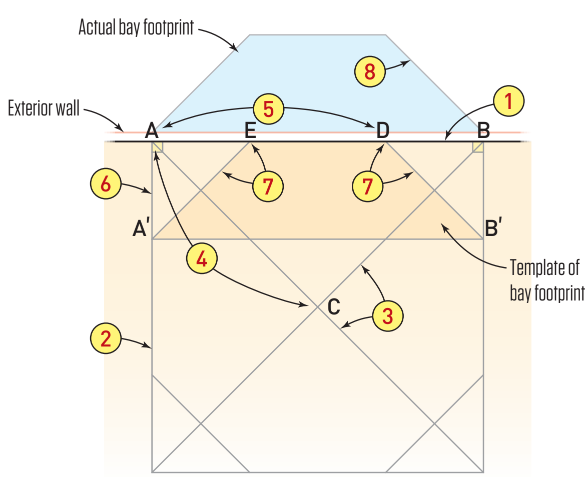
Construct a Square



Hexagonal Bay Window



Octagonal Bay Window

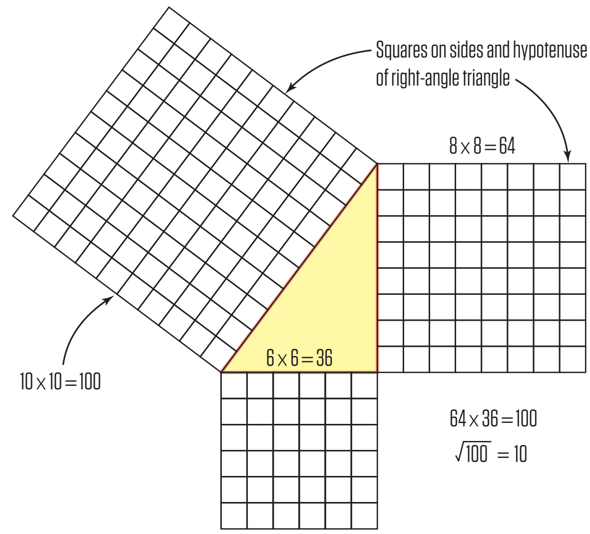


1. **A-B** is our interior wall line where we'll set a bay window
2. Draw a square with sides equal to **A-B**.
3. Draw the diagonals to locate the center of the square, **C**.
4. Measure the length from the center to one corner of the square (equal to **A-C**).
5. Measure this "half diagonal" distance from each end of the wall line (from left, **A-D**, from right **B-E**).
6. Define the rectangle **A-B-B′-A′** with the short side equal to **A-A′**.
7. From the corners **A′** and **B′** connect the diagonal to points **E** and **D**. The section **A′-E-D-B′** defines the template for the bay window.
8. Use template to define the footprint of bay window on the exterior of wall **A-B**.

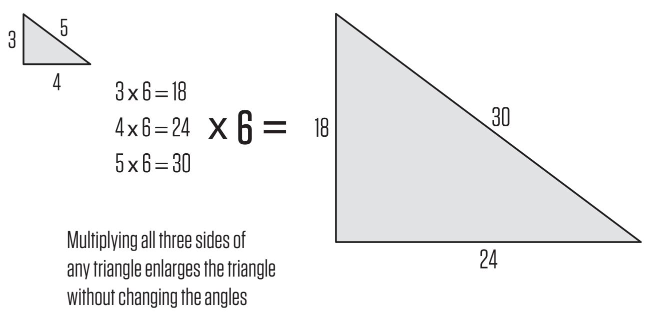
Leveraging the Pythagorean theorem. When we frame roofs or square large areas like a floor frame or lay out plates in preparation to stand walls, we can't avoid the Pythagorean theorem: $a^2 + b^2 = c^2$. If the abstract nature of this formula makes you nervous, it may be helpful to see the equation spelled out in geometric form, as shown at right. (This visual explanation also gives us a construction of the square root function that maps the area of a square to its side length.) The example shown here is a 6-8-10 right triangle—a larger form of the all-powerful 3-4-5 right triangle; if one leg of a triangle measures 3 and the other 4, we know by the Pythagorean theorem that the diagonal measurement will be 5. But we don't have to calculate this. Rather, we can use these dimensions as a check for square for any right angle: By measuring out one side equal to 3 units (inches, feet, anything) and the other side equal to 4 units, we know the hypotenuse connecting these sides will equal 5 units—or any multiple of 3-4-5: 6-8-10, 9-12-15, 12-16-20, and so on. When you're squaring a floor or a foundation (see example, below), it's always most accurate to use the largest multiple for the walls that you are laying out.

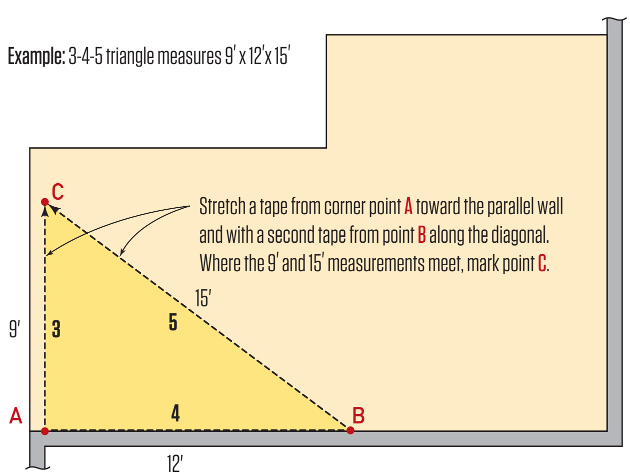
Additionally, the Pythagorean theorem relates to more than roof framing and right-angle layout; it can also be used to define the ellipse created where a vent pipe passes through a sloped roof. When the roof deck is part of the air barrier, we want to create a hole for the vent that can be tightly sealed.

Pythagorean Theorem Explained



3-4-5 Triangle





Intersection of Pipe Through Roof