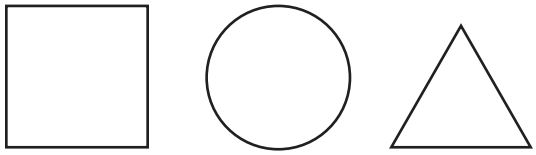
Basic Geometry

All forms are made up of three basic shapes: the square, the circle and the triangle; just as all colors are made up of the three primary colors: red, blue and yellow.



To draw a Perfect Square

Step 1. Draw a horizontal line. (fig. 1)
Step 2. Draw a vertical line. (fig. 2)
Step 3. Draw a 45 degree line starting at the intersection of the horizontal and vertical line. (fig. 3)
Step 4. Draw another vertical line, starting at the distance over on the horizontal line that you want the square to be. Bring the line up until it reaches the diagonal line. (fig. 4)
Step 5. Draw another horizontal line starting it where the diagonal and vertical lines intersected in Step 4. Bring the line across until it reaches the first vertical line. (fig. 5)
Step 6. Erase away any excess line endings.

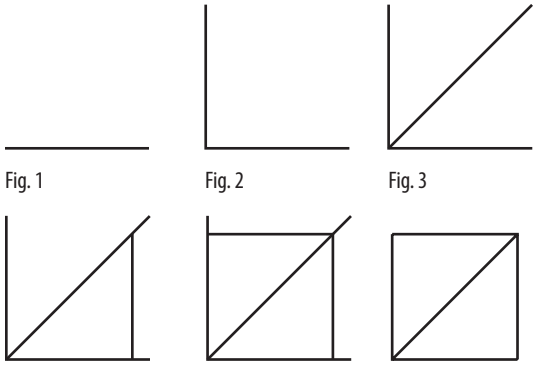
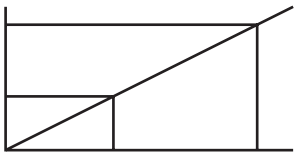


Fig. 1 Fig. 2 Fig. 3

Fig. 4 Fig. 5 Fig. 6

TIP: THE DIAGONAL

The diagonal can be used to enlarge or reduce. Both of these rectangles are proportionally related to each other. The diagonal line will keep the relationship anywhere along it, so you could reduce or enlarge the rectangle to any size necessary.



To Subdivide a Square:

Step 1. Draw a perfect square. (fig. 1)
Step 2. Draw in another 45 degree line opposite the one used to create the square. (fig. 2) The intersection is the center of the square.
Step 3. Draw a vertical line going through the intersection if the diagonals. (fig. 3) This splits the square in half horizontally.
Step 4. Draw a horizontal line going through the intersection of the diagonals. (fig. 4) This splits the square in half vertically, and as you can see the square is now broken down into four equal smaller squares.
If necessary you can repeat these steps on one of the new smaller squares. (fig. 5)

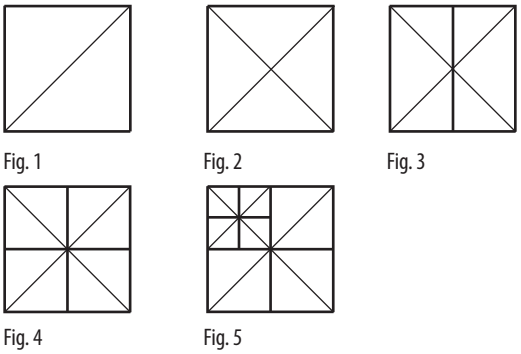


Fig. 1 Fig. 2 Fig. 3

Fig. 4 Fig. 5

Divide a Square or Rectangle into Thirds:

Step 1. Find the center of a square by intersecting two diagonals. (fig. 1)
Step 2. Draw a horizontal line through the intersection of the diagonals. (fig. 2)
Step 3. Draw lines (ab) and (ac). (fig. 3) Where (ab) and (ac)intersect the diagonals forms points (d) and (e). (fig. 3)
Step 4. Draw vertical lines through points (d) and (e). (fig. 4) The square is now divided into thirds horizontally.

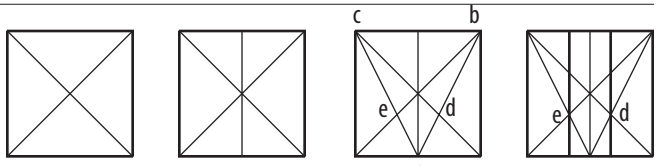


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Adding to a Square:

Step 1. Draw a perfect square. (fig. 1)
Step 2. Extend the horizontal lines out one side. (fig. 2)
Step 3. Draw a 45 degree line down from the corner of the square until it reaches the bottom horizontal line you extended out. (fig. 3)
Step 4. Draw a vertical line up from the intersection of the new diagonal, and the bottom horizontal, until it reaches the upper horizontal. (fig. 4)
The square has now been doubled.

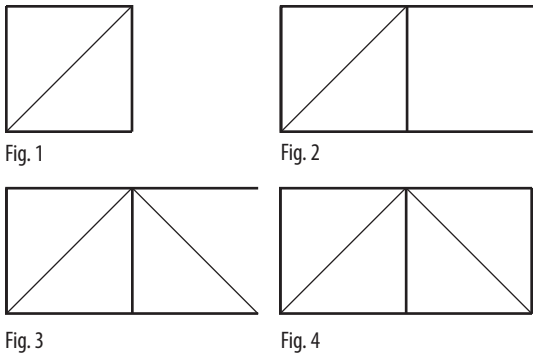


Fig. 1 Fig. 2 Fig. 3 Fig. 4

The Golden Section

Step 1. Draw a perfect square and extend the horizontal lines out as shown. (fig. 1)
Step 2. Draw a line from point (a) to point (b). (fig. 2)
Step 3. Using point (a) as the center, draw an arc starting at point (b) down to where it reaches the bottom horizontal at point (c). (fig. 3)
Step 4. Draw a line perpendicular to the bottom horizontal up from point (c) until it reaches the upper horizontal. (fig. 4)

The Golden Section is Nature's ratio. It can be found in a pine cone, flower, nautilus shell, and many other natural forms. The Golden Section equals 1 unit plus 0.618 units (1.618). The numerical sequence of the Golden Section, the Fibonacci Sequence, is (0,1,1,2,3,5,8,13,21,34,55,89 ,...). A number in the series divided by the following number yields an apprzimante result of 0.618, and a number divided by the preceding number yields an approximate result of 1.618.

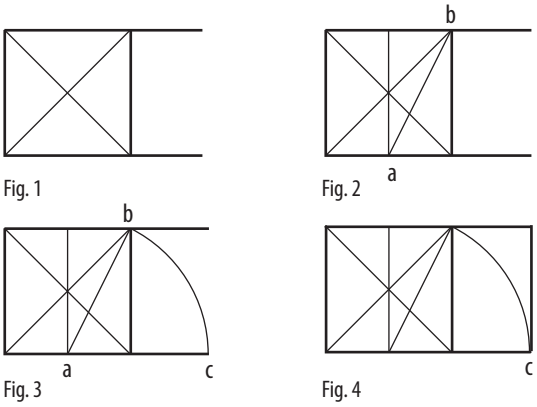
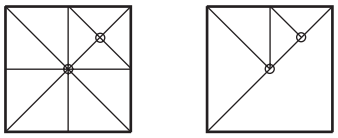


Fig. 1 Fig. 2 Fig. 3 Fig. 4

TIP: LESS IS MORE!

When using geometry to prove a point keep the geometry to a minimum to make it more understandable. The square on the right is much easier to read, but be careful that you don't remove too many lines and can no longer prove the point.


Too many lines Good solution

Semicircle Drawn Without a Compass:

Insert two nails into a board. push the sides of a 90 degree angle against the nails and mark where the point is. Repeat this process, moving the angle each time. When the points are connected they will form a perfect semicircle. (Fig. 1)

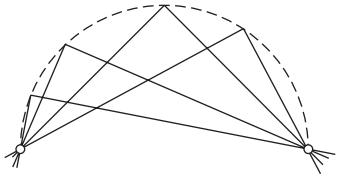


Fig. 1

Constructing an Egg Shape:

Step 1. Draw a circle and divide it into quadrants that intersect the circle at points (a), (b) and (c). (fig. 1)
Step 2. Draw a line starting at point (a) and extends through point (c). (fig. 2)
Step 3. Repeat step 2, but starting at point (b). (fig. 2)
Step 4. Using (bc) as a radius and point (b) as the center, strike an arc that intersects the (ab) line at point (e). (fig. 3)
Step 5. Using (bc) as a radius and point (c) as the center, strike an arc that intersects the (ac) line at point (d). (fig. 3)
Step 6. Using (ad) as a radius and point (a) as the center, strike an arc from point (d) to point (e).

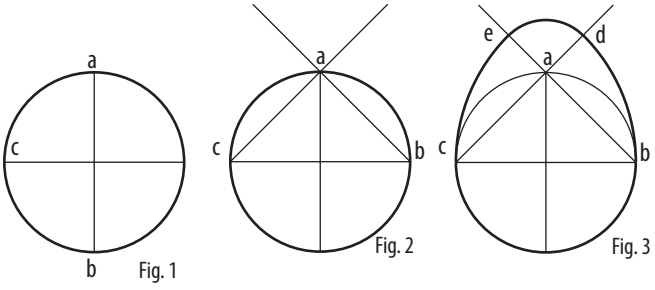
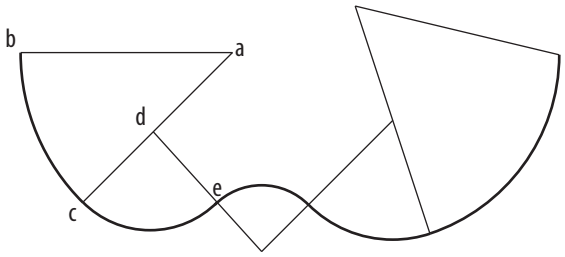


Fig. 1 Fig. 2 Fig. 3

To make a regular Curve With Arcs of a Circle:

The following steps indicate the principle by which any regular curved line can be constructed. The essential point is that any two consecutive arcs have centers on a common straight line. The consecutive arcs meet at only one point.

Step 1. Draw an arc so that point (a) is the center, point (b) is the start, point (c) is the end.
Step 2. Draw a line going through both the center of the arc, point (a), and the end of the arc, point (c).
Step 3. On the line (ac) find the center of the next arc, point (d). The next arc will begin where the last one stopped, point (c).
Step 4. Draw a line going through both the center of the point (d) and the end of the arc, point (e) .
Keep going until you have drawn the desired curve.



To Draw an Equilateral Triangle:

An equilateral triangle is a triangle that all three sides are of equal length.
Step 1. Draw a horizontal line (ab). (fig. 1) This will be the base of the triangle.
Step 2. Using (a) as the center and (ab) as the radius strike an arc. (fig. 1)
Step 3. Using (b) as the center and (ba) as the radius strike another arc. (fig. 1)
Step 4. Where the arcs intersect becomes point (c). (fig. 2)
Step 5. Draw lines (ac) and (bc) to complete the triangle. (fig. 2)

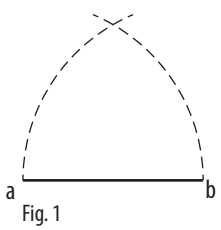


Fig. 1

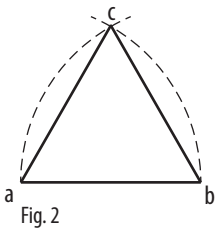
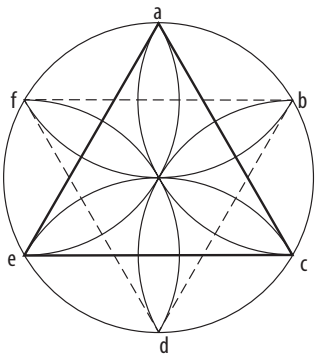


Fig. 2

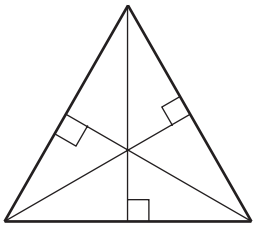
Constructing an Equilateral Triangle Within a Circle:

Step 1. Draw a circle.
Step 2. Using the same radius as the circle, with a center anywhere on the circumference of the circle (a), strike and arc through this circle. This arc would intersect the circle at point (B) and (f).
Step 3. Use point (b) as the center and strike another arc to create point (c). Repeat this step to create points (d) and (e).
Step 4. Once you have arcs using all six points as centers you can now create the equilateral triangle (ace) or (bdf).

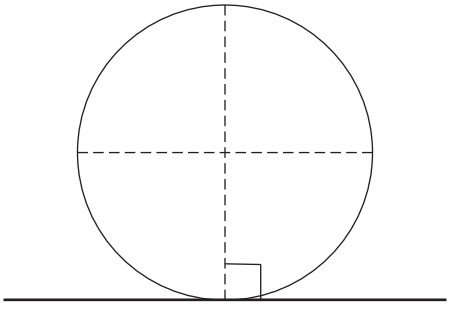


How to Find the Center of an Equilateral Triangle:

Step 1. Draw an equilateral triangle.
Step 2. Line your ruler up wit (ab).
Step 3. With the 90 degree side of your 45x45 triangle draw a line that goes through angle (c).
Step 4. Repeat steps 2 and 3 but use (bc) and go through (a).
Step 5. Repeat steps 2 and 3 but use (ac) and go through (b).
Where the three lines intersect will be the center of the triangle.

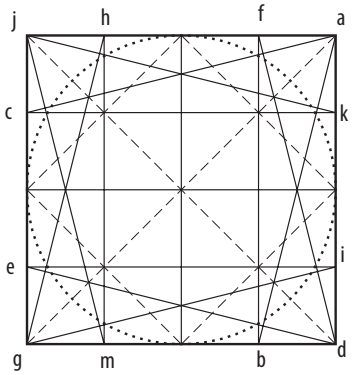


NOTE:
In geometry tangent refers to the touching of a curved line or surface at one point.
A tangent is a line which has one point in common with the circumference of a circle. A circle resting on a flat plane touches that plane at only one point. That point is known as the point of tangency. At the tangent point, the center of the circle is 90 degrees to the plane on which it rests.



The Circle Drawn Without a Compass:

This system is only used to construct a circle in a perspective or paraline drawing, when you cannot use a compass. You also must be certain you understand how to find a perfect square in the drawing before you can use this method to create the circle.
Step 1. Draw a perfect square and subdivide it into 16 equal units.
Step 2. Draw in the following lines: (ab), (ac), (de), (df), (gh), (gi), (jk) and (jm).
Step 3. Mark a point where the the following lines intersect:
(ab) with (ck), (de) with (bf), (gh) with (ei), (jk) with (hm), (ac) with (bf), (df) with (ei), (gi) with (hm), (jm) with (ck)
Step 4. Connect the points to form a circle.



How to Bisect a Line:

In geometry, bisect means divide into equal parts.
Step 1. Draw a line. Points (a) and (b) are ends of the line. (fig. 1)
Step 2. Using point (a) as the center strike and arc with a radius greater than half of the line (visually estimated) . (fig. 2)
Step 3. Repeat step 2, but use (b) as the center of the arc. (fig. 3)
Step 4. Draw a line through the intersection of the arcs. That line will divide line (ab) into two equal parts. (fig. 4)
The line is also perpendicular to line (ab).

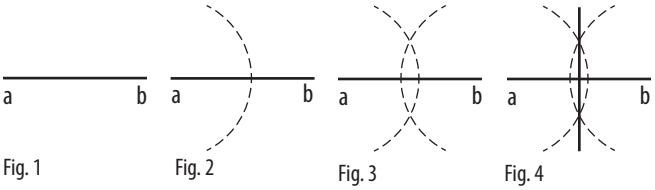


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Notice it was not necessary to draw the entire arc when bisecting the lines.

How to Find the Center of a Circle:

Step 1. Draw chord (ab) and bisect the line. (fig. 1) A chord is a straight line that cuts through any part of a circle at two points.
Step 2. Draw chord (cd) and bisect the line. (fig. 2) Where the two bisect lines intersect (point e) will be the center of the circle.

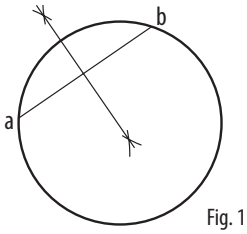


Fig. 1

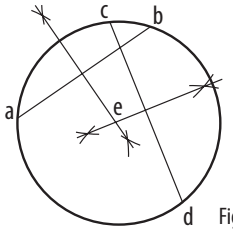
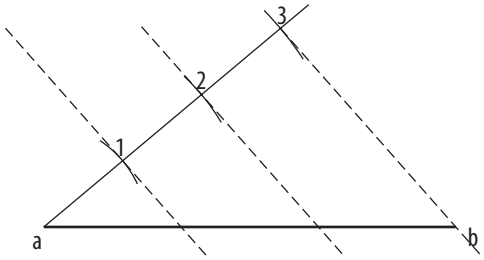


Fig. 2

How to Divide a Line into Equal Units:

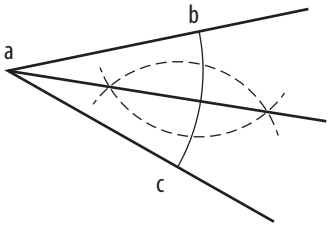
Given a line which is not divisible with a standard scaleof measurement. Line (ab). For the purpose of this example we want to divide line (ab) into three equal units.

Step 1. Draw a measuring line starting from one end of the line you want to divide, point (a), and mark off the three equal units.
Step 2. Draw a line going through point (3) and the other end of the line, point (b).
Step 3. Draw parallel lines to the line drawn in step 2 through point (1) and point (2).
Where these lines intersect line (ab) will divide the line into equal units.



How to Bisect an Unknown Angle:

Step 1. Draw an angle.
Step 2. Using (a) as the center strike an arc creating points (b) and (c), which are equidistant from (a).
Step 3. using (b) as the center strike an arc with a radius that is more than half the distance to point (c) (visually estimated).
Step 4. Repeat step 3 using the same radius, but use point (c) as the center of the arc.
Step 5. Draw a line through the intersection of the arcs. This line will bisect the angle (a).



Rounding the Corner of a Ninety Degree Angle:

Step 1. Bisect the angle with a 45 degree line (fig. 1). the center of the arc will fall upon this line.
Step 2. Measure the desired radius along the horizontal line, and transfer that measurement up vertically to the diagonal line. (fig. 1) This will be the center of the arc.
Step 3. Transfer the center horizontally over the vertical line to find the tangent point where the arc will end. (fig. 2)
Step 4. Draw the arc from tangent point to tangent point (fig. 2).
Rounding of parallel lines with 90 degree corners will share the same center point of the arc. (fig. 3) Only the radius of the arc will be different.

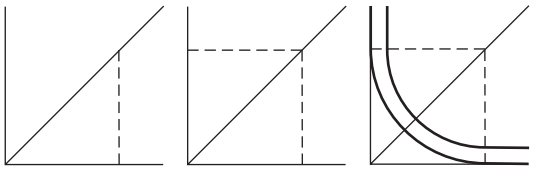


Fig. 1 Fig. 2 Fig. 3

Rounding the Corner of an Unknown Angle:

Step 1.Bisect angle (a), notice it was not necessary to draw the complete arc to get points (b) and (c). And when i intersected the arcs to find the bisect I only drew the outermost intersection (d). The center of the arc for the round will fall somewhere on this bisect line.
Step 2. On one side of the angle (a) draw a perpendicular line. In this example it starts at point (e). This is a measuring line.
Step 3. Measure and mark the distance you want the radius of the round to be, point (f).
Step 4. Draw a line parallel to the side of the angle starting at point (f). Where this line intersects the bisect line will be the center of the arc for the round, point (g).
Step 5. Draw lines perpendicular to the sides of the angle that go through point (g). These lines will give you the tangent point that will be the beginning and ending of the arc.
Step 6. Draw the arc.