The Magic Circle
Basic Lesson

Developed by

The Alexandria Seaport Foundation

The Tools Needed

- Compass
- Straightedge
- Pencil
- Paper (not graph paper, 8.5 x 11 is fine)
- Your Brain (the most important tool!)

Math Terms We'll Be Using

- Center
- Radius
- Circumference
- Fraction
- Percentage
- Degree
- Decimal
- Line
- Diameter
- Semicircle

- Right Angle
- Perpendicular Line
- Perpendicular Bisector
- Quadrant
- Coordinate Plane
- Axis
- Arc
- Intersection
- Square

- Rectangle
- Right Triangle
- Isosceles Triangle
- Equilateral Triangle
- Parallel Line
- Complementary Angles
- Supplementary Angles

Getting Started

- Place three sheets of paper on top of one another. Orient them sideways, horizontal or "landscape view."

- Use a pencil to make a dot in the approximate center of the paper. This is the **center** of your circle

- Set the compass, so the distance is approximately the length of your thumb. This is the **Radius** of your circle. Or, the distance from the center of your circle to any point on the circle. It's the measurement you need to know in order to draw a circle.
- Put the metal point of the compass on the dot in the center of the paper and draw a circle. The line you just drew is the **Circumference** of the circle. It's the circle's perimeter.
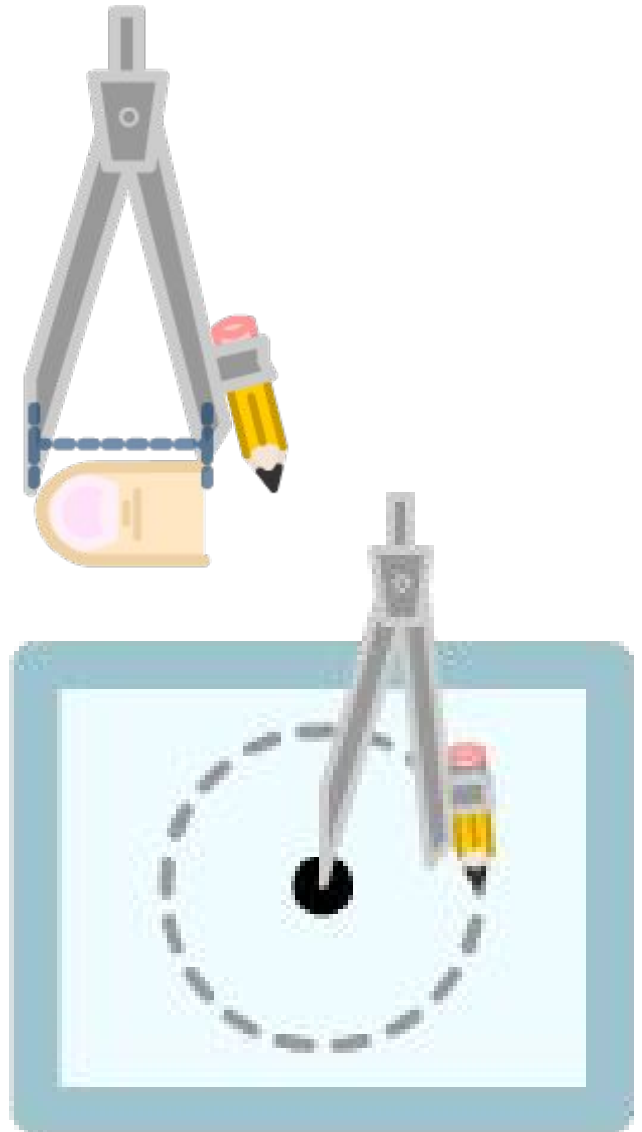
● It's now time to start writing down the math you are using.

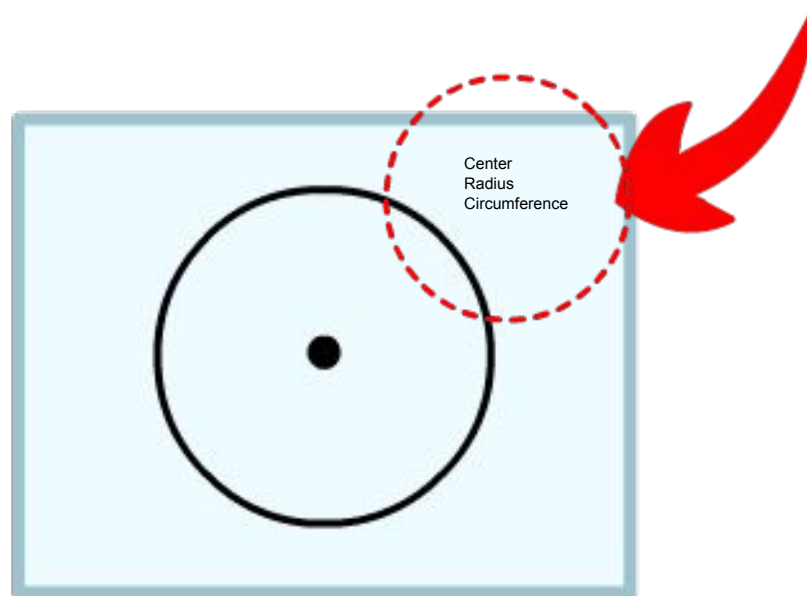Fractions are written in the upper left corner of the paper.

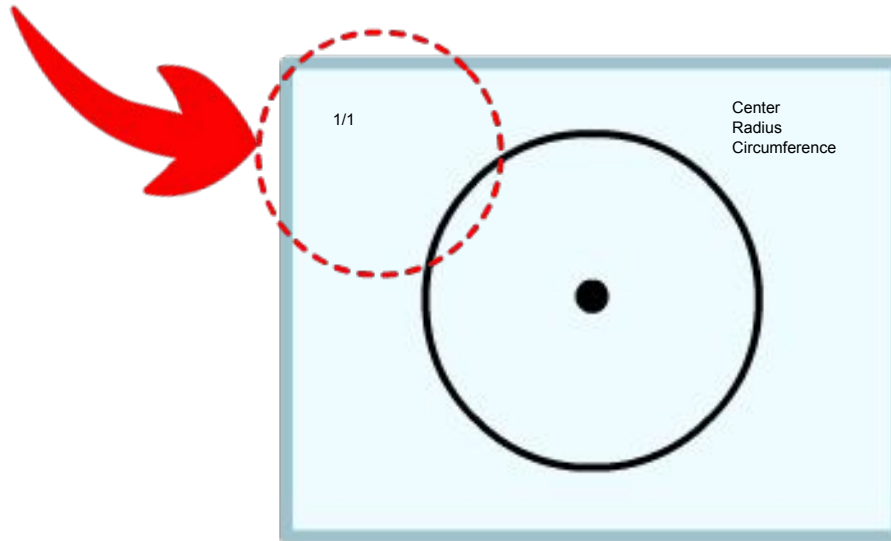Geometrical terms go in the upper right corner of the paper.
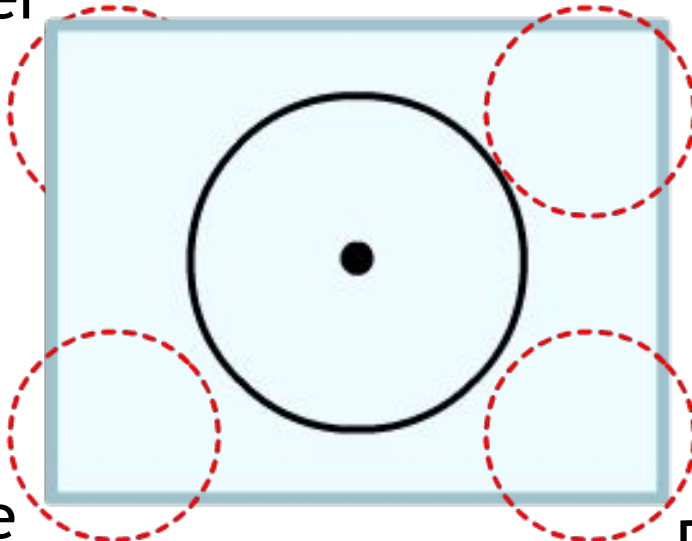
Percents go in the lower left corner.

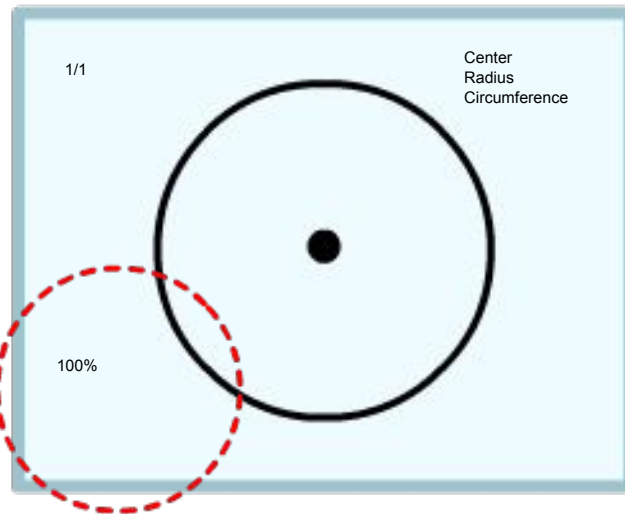Degrees go in the lower right corner.

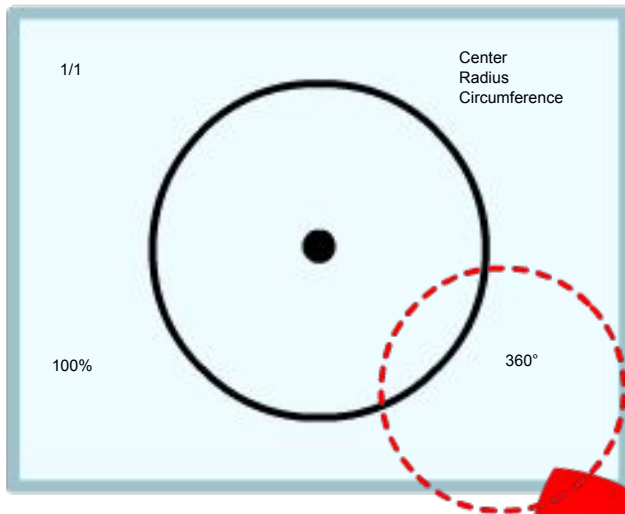● In the upper right corner of the paper, write *Center*, *Radius* and *Circumference*.

Center
Radius
Circumference

- In Fractions, a whole is *1/1*. Write that fraction in the upper left of the paper.
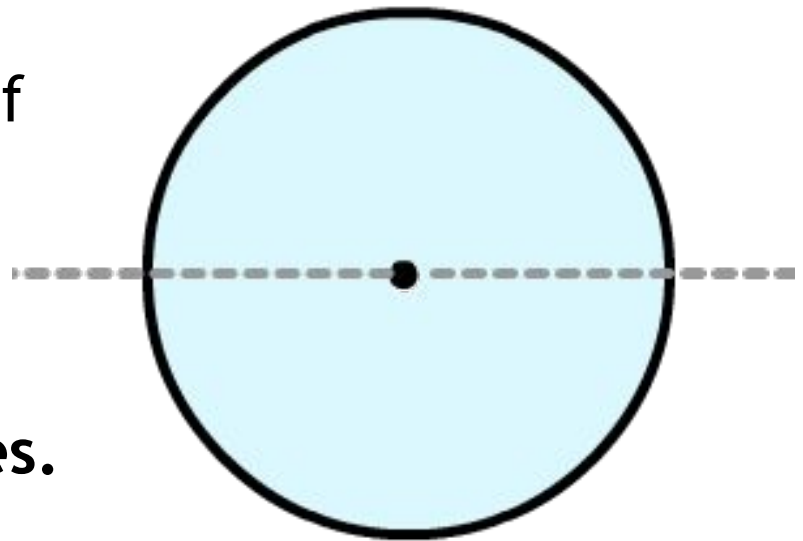
1/1

Center
Radius
Circumference

- One whole is 100%. Write **100%** in the lower left of the paper.

- A whole circle has 360 degrees. Write **360°**.

- Use the straightedge to draw a straight, horizontal **line** through the center of the circle and extending beyond the edges of the circle. This is the circle's **diameter**.
- By cutting the circle in half, you've formed two **semicircles.**

- Half of a whole is a half. 1/1 x ½= ½. Write ½ in the upper left hand corner of the paper, below 1/1.

1/1
1/2

Center
Radius
Circumference

100%

360°
180°
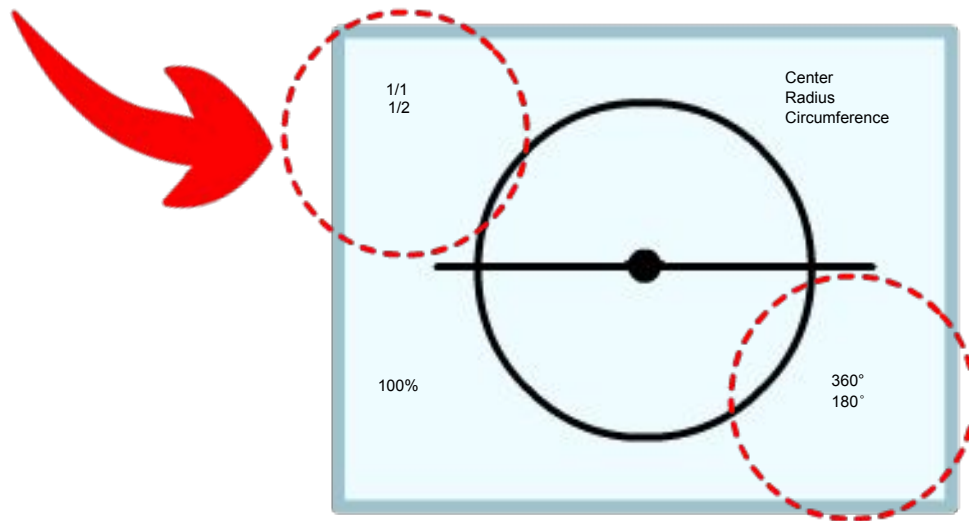
- Half of 360° is 180°. Write **180°** below 360° in the lower right corner of the paper. There are 180° in a straight line, a semicircle and the interior angles of a triangle.

- Write *line*, *diameter* and *semicircle* below "Circumference" in the upper right corner of the paper.
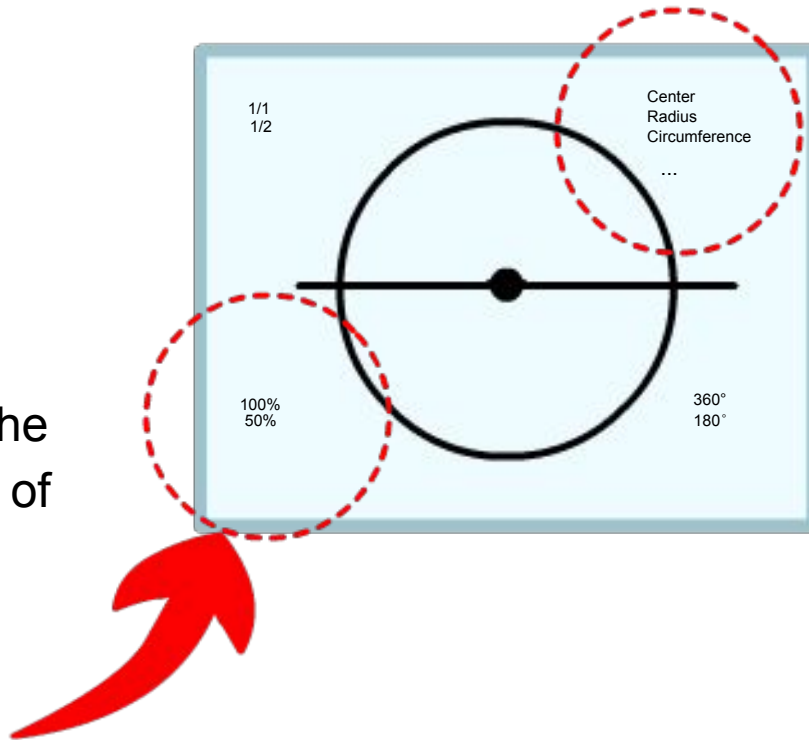
- Half of 100% is 50%. Write *50%* below 100% in the lower left corner of the paper.

1/1
1/2

Center
Radius
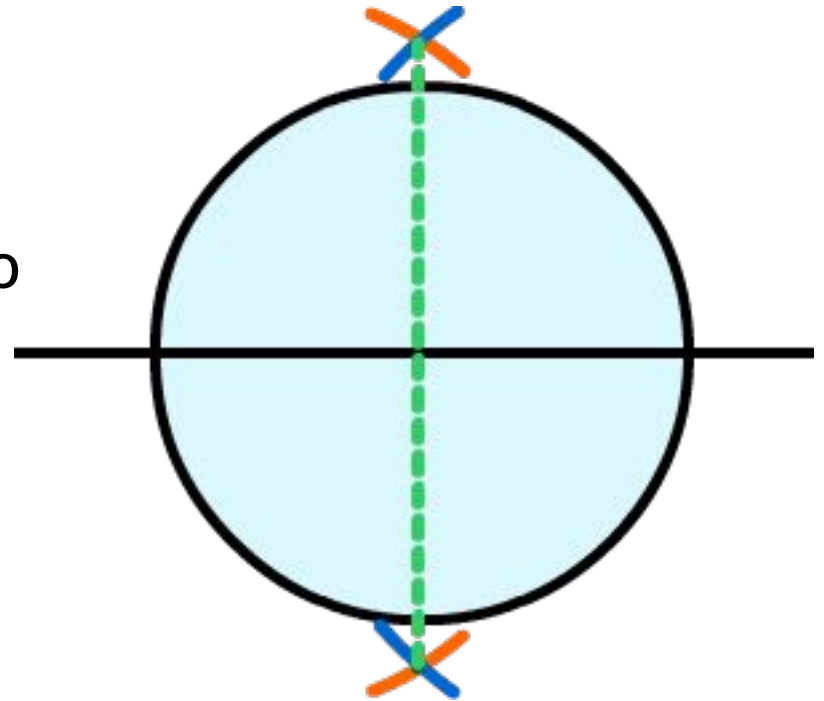Circumference
...

100%
50%

360°
180°

- Place the metal point of the compass on one intersection of the straight line and the circle. Open the compass, so that the distance is greater than three quarters of the way across the circle.
- Keeping the metal point of the compass on an intersection of the circle and straight line, swing **Arcs** above and below the center of the circle. An arc is any portion of a circle.
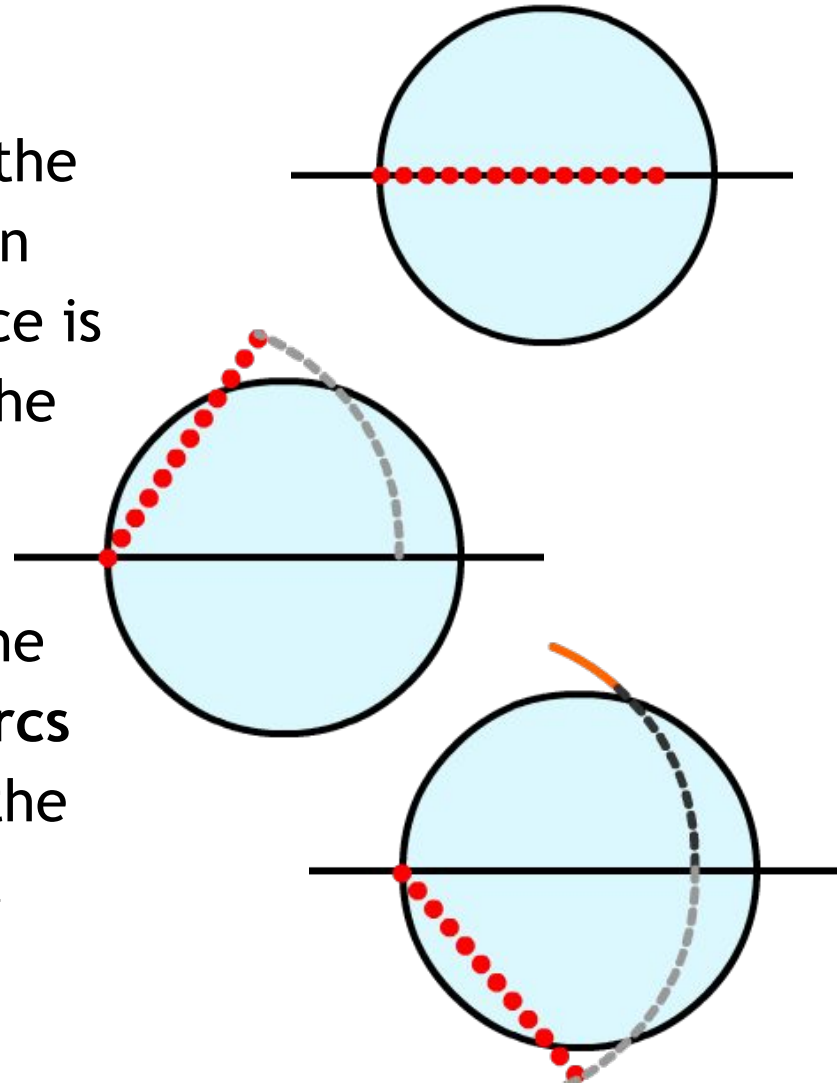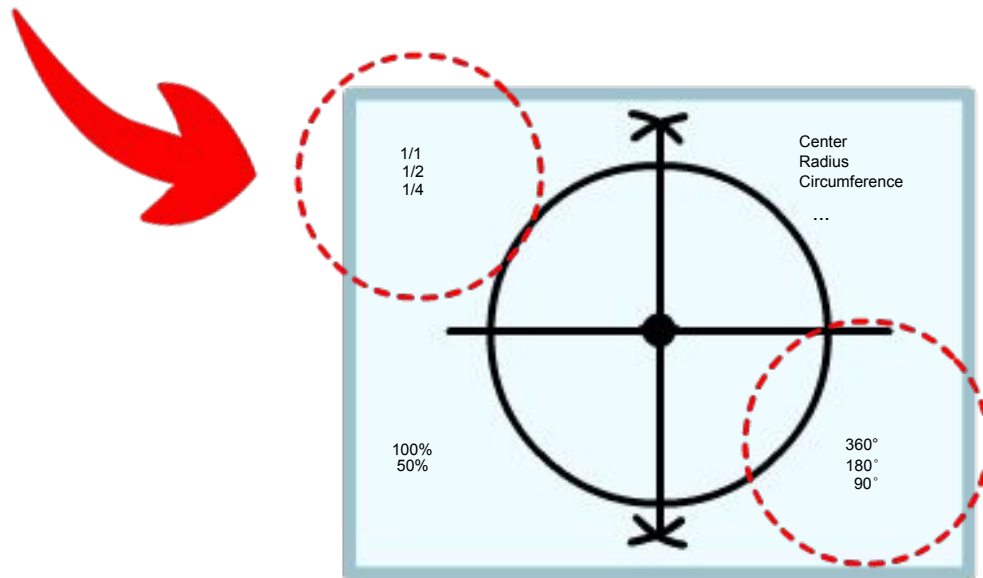
- Move the point of the compass to the opposite end of the line, where it intersects with the outside of the circle. Keep the distance between the points of the compass the same.
- Swing arcs above and below the center of the circle so that they intersect with the previous set of arcs.
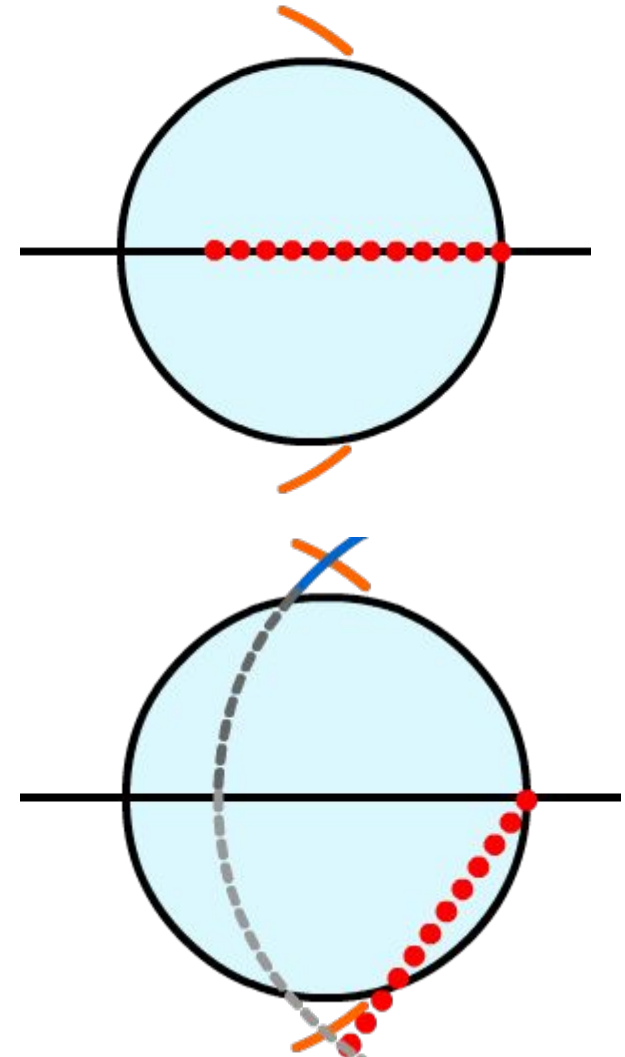
- The intersecting arcs should create two points. Use your straight edge and a pencil to connect those points. The resulting line should pass through the center of the circle.
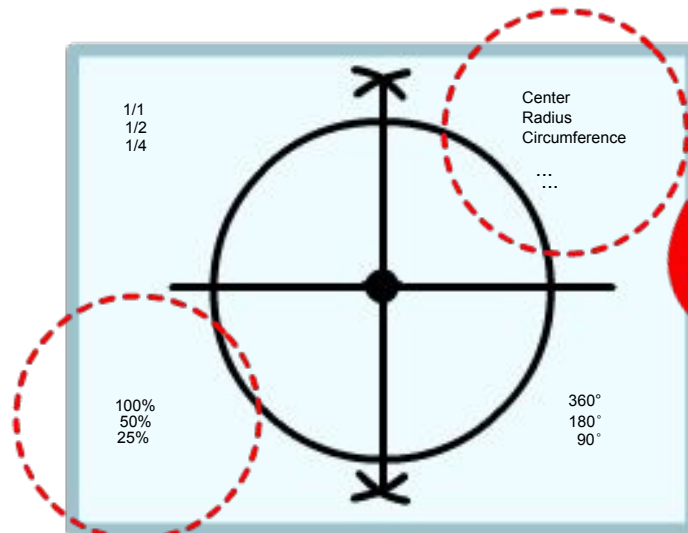
- Half of a half is a quarter. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$. Write **¼** underneath ½.

1/1
1/2
1/4

Center
Radius
Circumference
...

100%
50%

360°
180°
90°

- Half of 180° is 90°. Write **90°** underneath 180°. Write down the other names for "90 degrees". Right Angle, Square, Perpendicular and Normal. If it has so many names it must be important…

- The line you drew to cut the circles in quarters is called a **Perpendicular Bisector**. Perpendicular means 90°. Bisect comes from Latin. Bi means two. Sect means cut. A quarter of a circle is called a **Quadrant**. You've also just created a **Coordinate Plane** with two **Axis** and four quadrants.

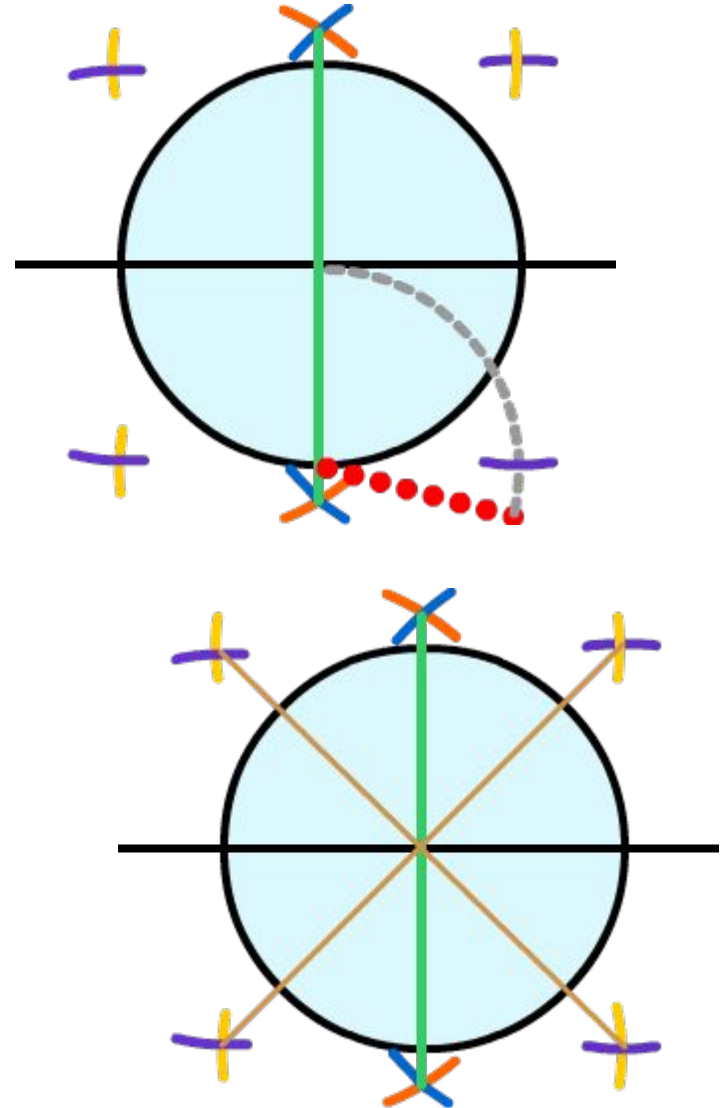1/1
1/2
1/4

Center
Radius
Circumference

...
...

100%
50%
25%

360°
180°
90°

- Write ***Perpendicular Bisector***, ***Quadrant***, ***Coordinate Plane***, and ***Axis*** in your list of terms.
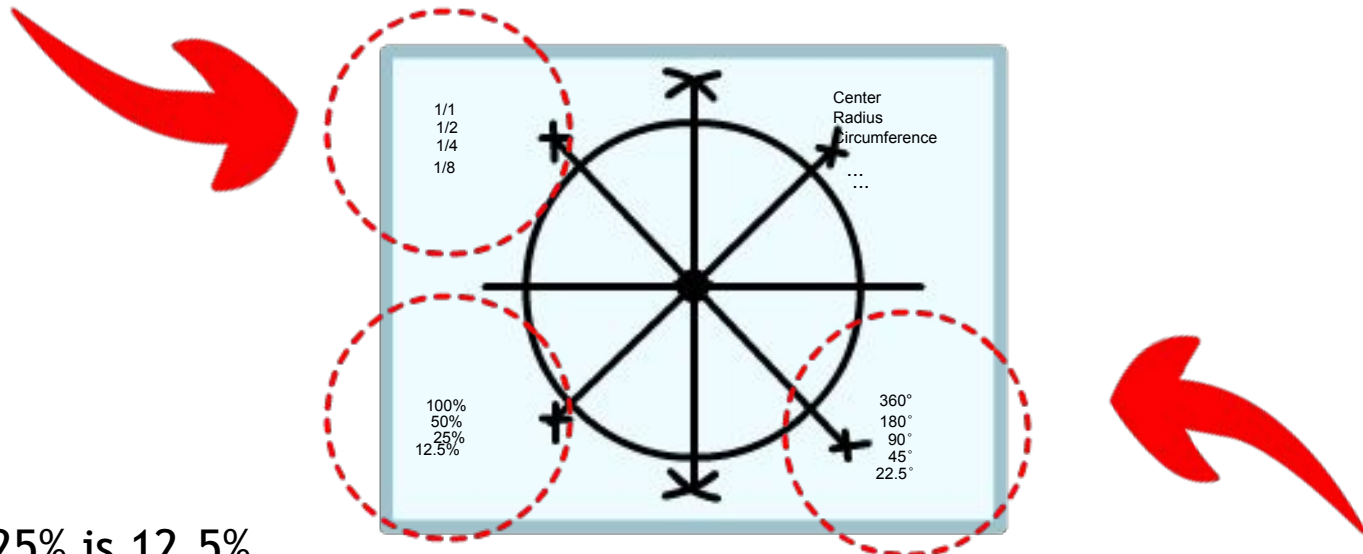
- Half of 50% is 25%. Write **25%** underneath 50%.

● Close the compass to the original distance you used to draw the circle.

● There are now four places where the diameter and perpendicular bisector intersect the outside of the circle.
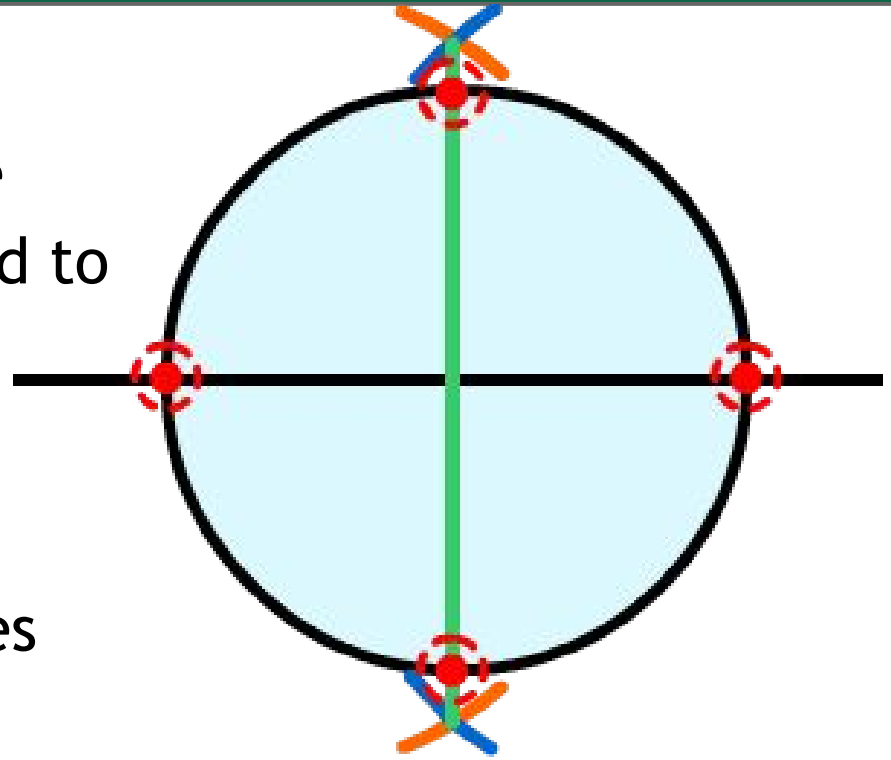
- Place the metal point of the compass on each of those points and swing arcs to the left and right of those points, outside of the circle. Four points should be created from the intersecting arcs.
- Draw lines from these points through the center of the circle.

- Half of a quarter is an eighth. ¼ x ½= ⅛. Write **⅛** under ¼ in the upper left corner of the paper.

1/1
1/2
1/4
1/8

Center
Radius
Circumference
...
...

100%
50%
25%
12.5%

360°
180°
90°
45°
22.5°

- Half of 25% is 12.5%. Write **12.5%** underneath 25% in the lower left corner of the paper.

- Half of 90° is 45°. Write **45°** underneath 90° in the lower right hand corner of the paper.

- Locate where these latest lines cross the outside of the circle.
- Starting with the upper right point, using the straightedge, connect that point to the point on the upper left. Connect that point to the lower left point. Connect the lower left point to the lower right point. Connect the lower right point to the upper right point.
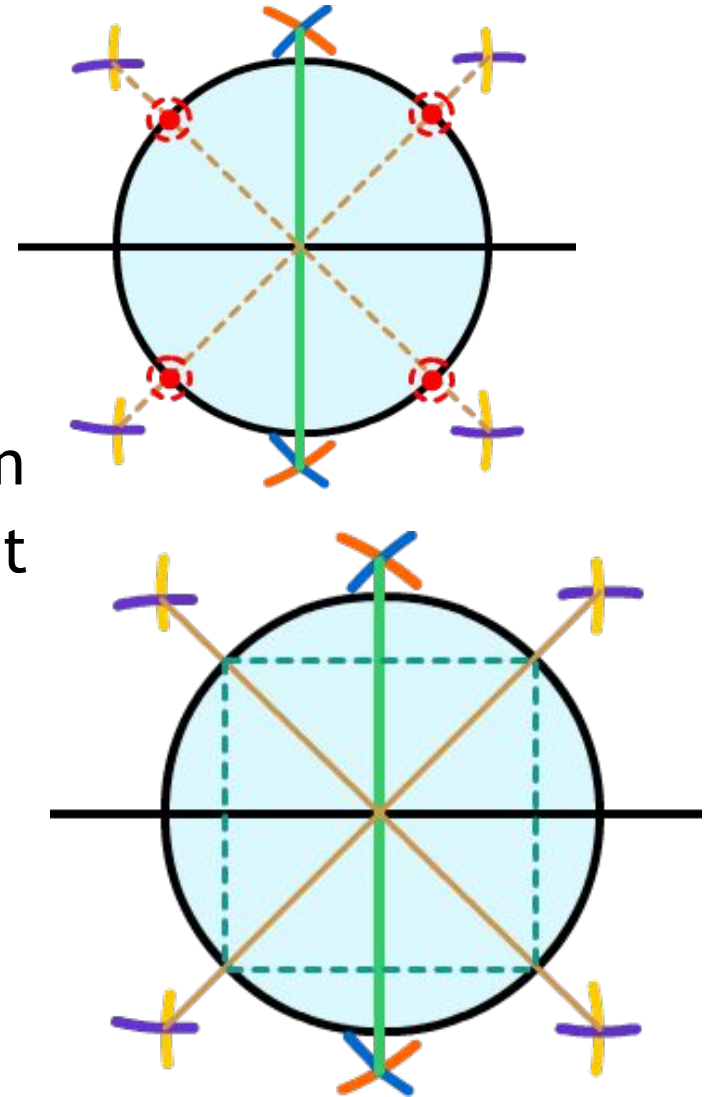
- You've now created a multitude of geometric shapes. Locate the square, rectangles, Isosceles Triangles and right triangles.

- Write "Square", "Rectangle", "Isosceles Triangle" and "Right Triangle" in the list of terms.
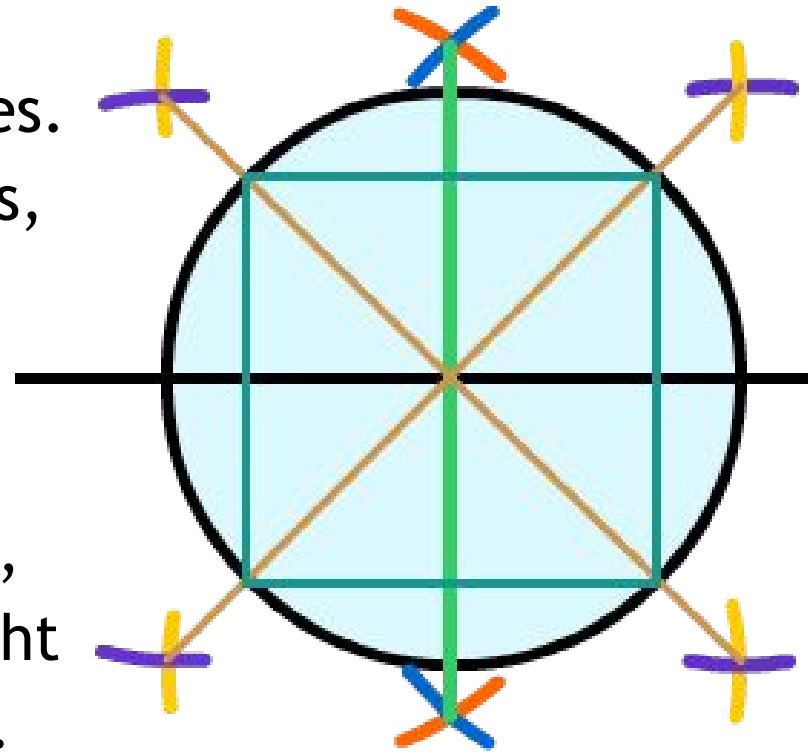
- Next, take the compass and put the metal point where the second line you drew crosses the top of the circle. Make sure the compass is set to the distance you used to draw the circle. Swing an arc to the right, so it crosses the outside of the circle.

- Using the straightedge, draw lines from the resulting point back to:
  - The point where you had placed the metal point of the compass, and
  - The center of the circle.
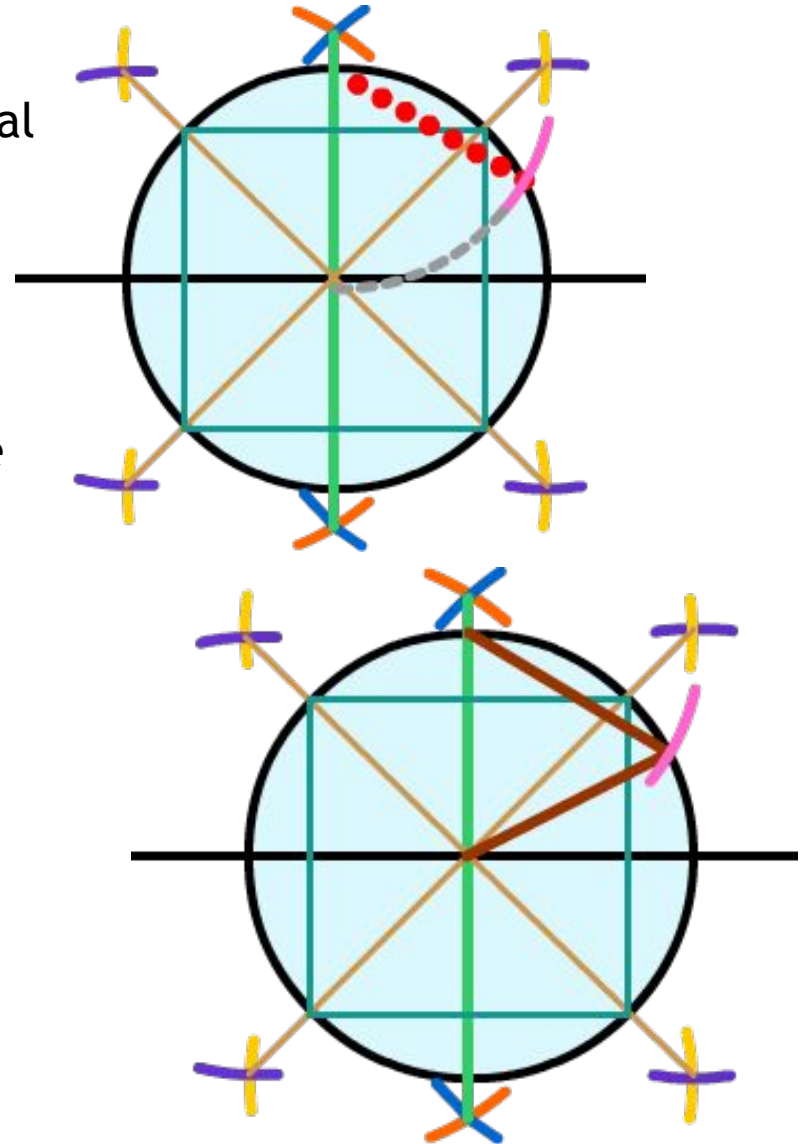
- You've created an equilateral triangle. Each side is the same length (the radius of the circle.) Each interior is the same, 60°. Since the triangle is drawn within a quadrant of a circle, which has 90°, the complementary angle to 60° is 30°. So, you've also created a 30° angle.
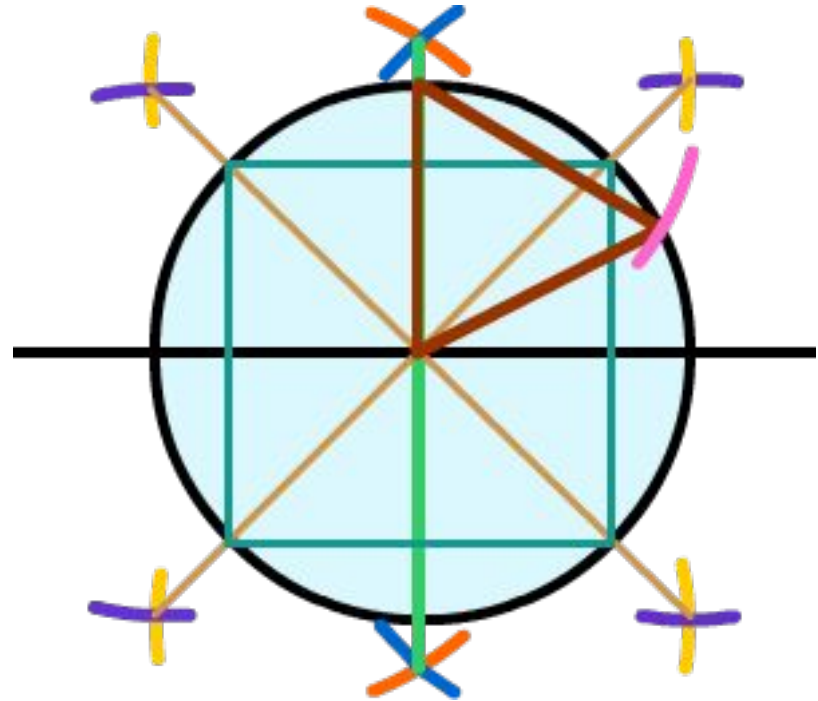
- Write 60° and 30° underneath 12.5°

- Find an angle in your classroom, or shop, which you haven't drawn during this exercise. There won't be many because 360°, 180°, 90°, 45°, 12.5°, 60° and 30° are the most common angles used in architectural drawing.

- In a related exercise, you can draw this exercise on cardstock and cut out the shapes to create their own drafting tools.
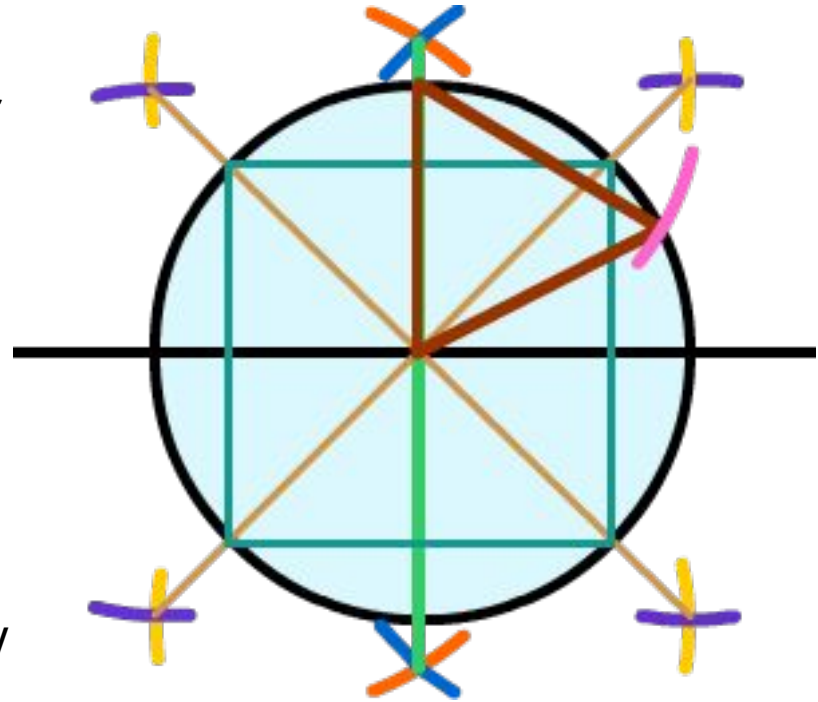
Adding Fractions

A fundamental rule of math is that you must work in similar "units." You can't add apples to oranges. Nor can you add a ½ to and ⅛th without first converting one half into four eights. This can be readily demonstrated using the circle segments created in the Magic Circle.

Converting Percents to Decimals

Percents are converted to decimals by moving the decimal place two spaces to the left.

100%=1, 50%=.50, 25%=.25, 12.5%=.125

Comparing Fractions to Percents and Decimals

Write a chart comparing fractions, percents and decimals. This is a basic conversion chart for the fractions of an inch used on a standard ruler.

1/1	100%	1.
1/2	50%	.5
1/4	25%	.25
1/8	12.5%	.125