BASIC GEOMETRY CONCEPTS AND DEFINITIONS:

Geometry: It is an area of knowledge which studies any elements and operations on/in the plane such as points, lines or shapes. It comes from the Greek geo “earh”, metry “measurement”.
Point: In geometry a point can be defined as the place or location where two lines intersect. A point has no dimensions, no height and no width.
Line: a one-dimensional object formed of infinite points . It has no end points and continues on forever in a plane.
Ray: A line which begins at a particular point (called the endpoint) and extends endlessly in one direction.
End point:An End Point is a point at which a line segment or a ray ends or starts.
Midpoint:It is the point that is halfway between the endpoints of the line segment.
Line segment: It is a line with two endpoints
Straight line: A line whose points follow the same direction.
Plane: It is a two-dimensional (height and width) surface. In the space a plane can be defined by two paralel lines, two intersecting lines or one point and a straight line.
Length:Measurement of something from end to end

Listen and watch this **video about basic geometry language** online
http://youtu.be/il0EJrY64qE

AB are End points for the line segment, C is its midpoint. D is the Ray's Endpoint.

GEOMETRY DRAWING AND SUPPLIES CONCEPTS AND DEFINITIONS:

Freehand: Drawn by hand without guiding instruments, measurements.
Line/Technical drawing: It is a drawing made with the help of supplies. It is usually the kind of drawing used for architecture or enginering **plans**.
Compass: It is a tool for drawing circles and arcs and also for measuring distances between points, consisting of two arms linked by a hinge.
Protractor: an instrument for measuring or drawing angles on paper, usually a flat semicircular transparent plastic sheet graduated in degrees
Set squares (UK) Triangles (US): They are two special rulers with a triangular shape. One is called the **45º triangle (45ºsquare, UK)** and the other the **30/60º triangle**. Both have the 90º angle. So, they are used to draw certain angles and also to draw parallel lines.
Eraser (Rubber, UK):an object, such as a piece of rubber, used for deleting something.
Marker (Felt-tip pen, UK): a pen having a writing point made from pressed fibres.
Ruler: An instrument used to draw straight lines. Also called straight edge

COMPLETE THE FOLLOWING SENTENCES:

1- I need a .....to draw a perfect circle.

2- If you don’t use the..... you won’t get perfect parallels.

3- See my ..... drawing!!! now i’m going to use instruments to draw it more accurately
.
4- If you use a pencil, you can use an..... to delete the lines.

5-Have you seen my ....? It is a plan to build a house.

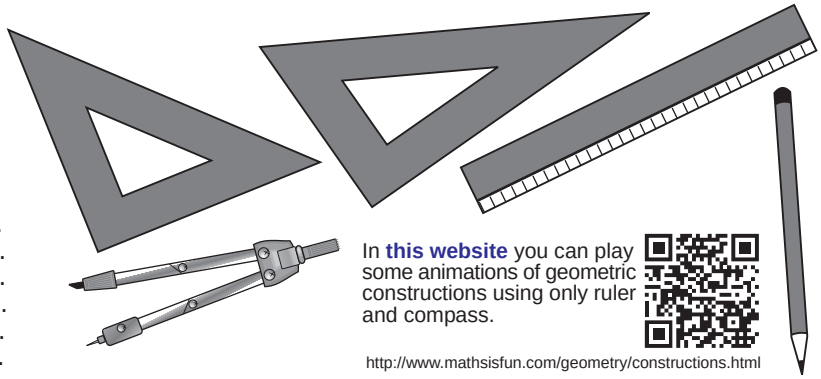
WHAT WOULD YOU USE TO DRAW...:

1- Perpendicular lines?.....
2- A set of concentric circles?.....
3- A long straight line?.....
4- A circle?.....
5- A few paralel lines?.....
6- A portrait?.....
7- An arc?.....
8- A landscape?.....
9- Certain angles?.....
10- copying lengths?.....

There are two types of main geometries: Planar Geometry, which only studies flat objects (two dimensional) such as points, lines and shapes; And Descriptive Geometry that studies the depiction of three dimensional objects like polihedra or other shapes or solids with volume.

For studiying and practising planar geometry we will use the supplies shown below. But some people only uses a compass and a ruler and that is called "straight edge geometry".

There is also a "rusty compass" geometry that never changes the radius of the compass for its constructions, and Mascheroni demonstrated that geometry can be made only with a compass without a ruler.

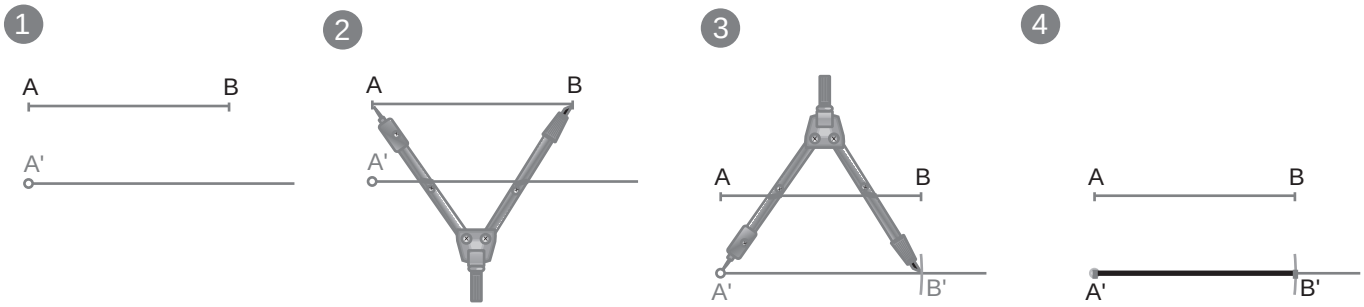


In **this website** you can play some animations of geometric constructions using only ruler and compass.
http://www.mathsisfun.com/geometry/constructions.html

To perform operations (additions or subtractions) with line segments we always use the compass to take lengths, to copy or move them. A ruler must be used to make the straight lines, while the compass will be the tool that works for giving lenghts to the segments.

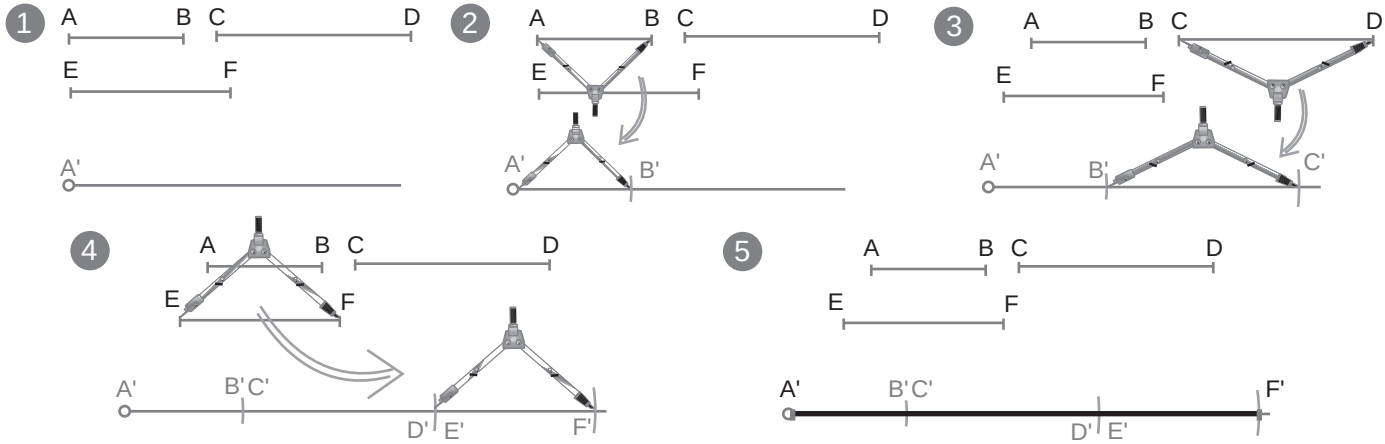
LINE SEGMENT COPYING: Given the segment AB, copy it with the same length.

1st- Draw a ray from point A'.
2nd-With the compass take the legth AB.
3rd- Take the legth AB, kept with the compass. Set the center on the ray's point A' and draw an arc obtaining B'.
4th- Finally enhance with black ink the result (Important).

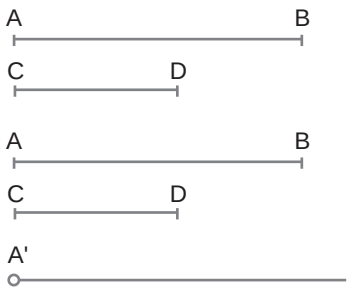


LINE SEGMENTS ADDITION: Given the line segments AB, CD and EF, add them graphically.

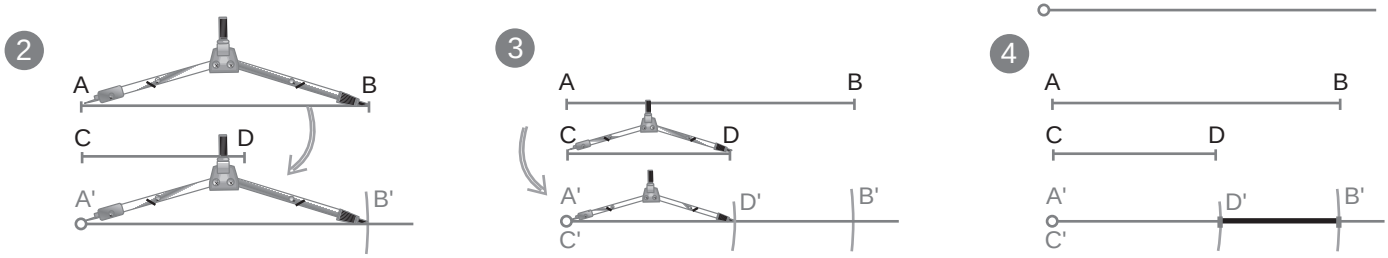
1st- Draw a ray from the point A'.
2nd-With the compass take the legth AB, and copy it on the ray from A', obtaining B'. (This is AB segment line copying)
3rd- From B' we repeat the operation with the following segment line to add (CD).
4th- In this case we need to add three segments to get the addition. we repeat the operation with the last one.
5th- The result is the total of the three segments copied one right next to the other. That is to say, A'F'. We enhance the result with black ink (IMPORTANT).



LINE SEGMENTS SUBTRACTION: AB - CD, subtract them graphically.



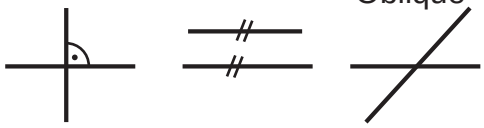
1st- Draw a ray from the point A'.
2nd-Take, with compass, the AB length, the longest one, and copy it onto the ray from A', obtaining B'. (AB segment line copying)
3rd- From A' we repeat the same operation with the segment CD. That is to say, we will copy the smaller segment onto the longer one already copied.
4th- The diference of lengths, length fromD' to B', is the result. We must enhance the result with black ink.



IMPORTANT DEFINITIONS ABOUT ANGLES AND LINES:

Parallels: They are lines which never intersect themselves, so all their points are equidistant.
Perpendicular: They are lines which meet forming four right angles.
Oblique / Skew: They are lines which are not parallels neither perpendicular.

Perpendicular Paralels Skew or Oblique



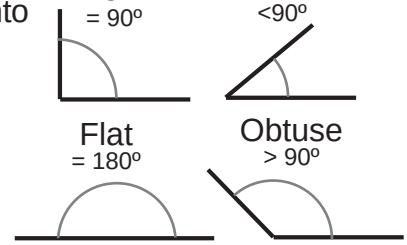
ANGLE: It is a figure formed by two rays (sides of the angle) sharing a common endpoint (vertex).

Complementary Suplementary Adyacent

Complementary angles: They are couples of angles which sum is 90º.
Suplementary angles: They are couple of angles which sum is 180º.
Adyacent angles: They are angles that share one side and the vertex.

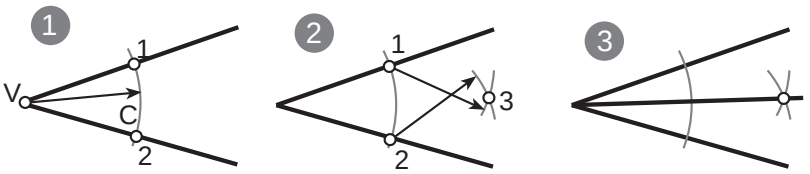
Angle bisector: It is the line segment or ray which divides an angle into two equal parts
Right: A right angle has 90 degrees.
Obtuse: A obtuse angle has more than 90 degrees.
Acute: An acute angle is the one that has less than 90 degrees.
Flat: A flat angle has 180 degrees.

Right = 90º Acute <90º Flat = 180º Obtuse > 90º



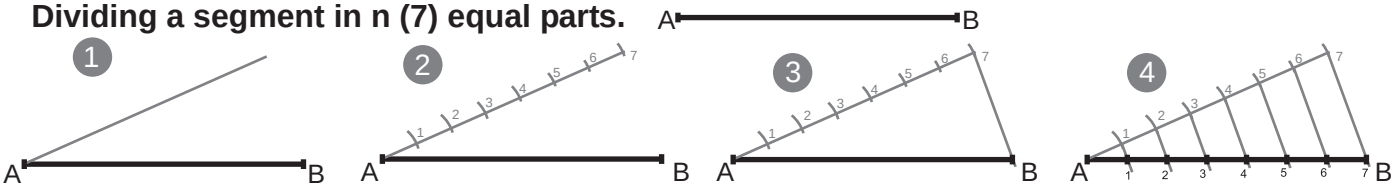
The angle's bisector

1st-With any radius and center on V vertex, draw an arc which intersects the rays of the angle in two points, 1 and 2.
2nd-Centered in these two points and a radius longer than half of the distance between them, draw two arcs which intersect in a point, 3.



3rd-Conect the point 3 with V vertex.

Dividing a segment in n (7) equal parts.

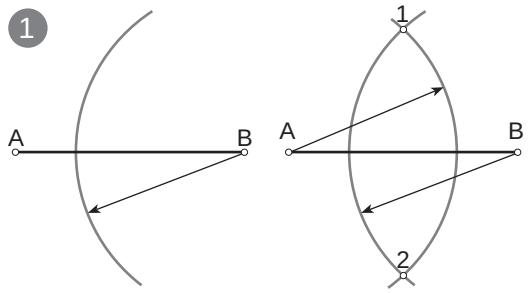


1st- From A endpoint trace a ray forming any angle with the segment.
2nd-Using the compass, tracing arcs, (or a ruler) and with any lenght make seven equal parts (starting from the A endpoint) on the ray.
3rd-Conect the last division (7) with the other endpoint (B) of given segment. 4th-Draw parallels to 7-B segment through each division on the ray.

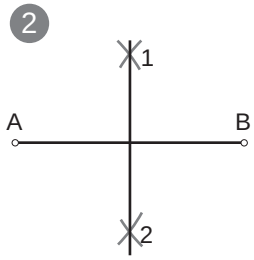
Perpendicular segment line bisector:

Given the segment AB, Draw its perpendicular biscetor.
A line segment's perpendicular bisector is a perpendicular line through its midpoint. It can also be defined as "A set of points that are equidistant from the two endpoints of a line segment."

Construction:



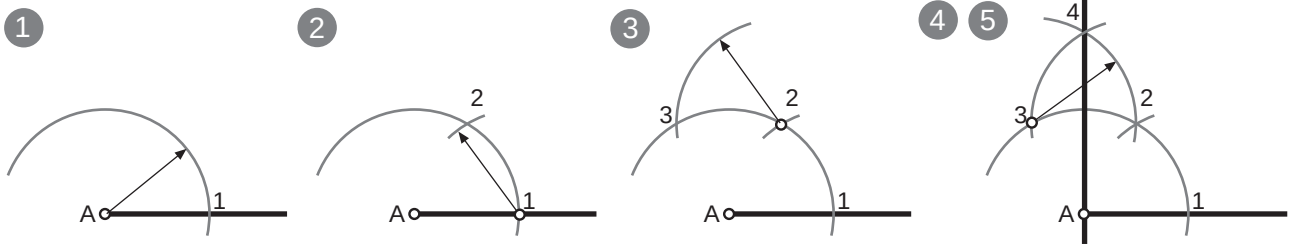
1st- Draw two arcs with same radius centered in endpoints A and B. Two points, 1 and 2, are obtained where both arcs intersect.
2nd- Conect 1 with 2 to obtain the perpendicular line bisector. Enhance the result with black ink.



Perpendicular line of a segment through an end point:

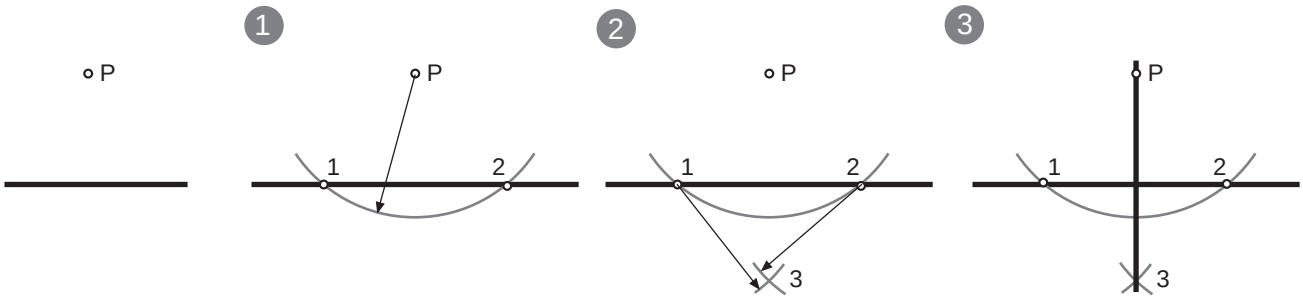
Given a line segment AB, draw a perpendicular line through its endpoint A.

1st-Draw an arc, with any radius, centered in A (close to half circle), this intersects the given line in point 1.
2nd-With the same radius, draw an arc centered in point 1, this intersects the first arc in point 2.
3rd-With the same radius, draw an arc centered in point 2, this arc intersects the first arc in point 3.
4th-With the same radius, draw an arc centered in point 3, this intersects the last arc in point 4.
5th-Connect points 4 and A. Draw the result with black ink.



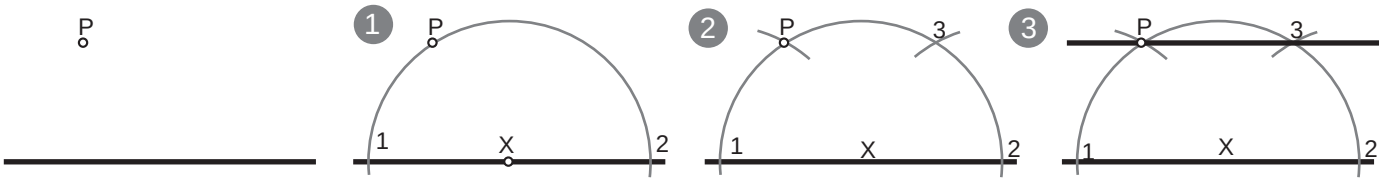
Perpendicular line to another through an outer point of it:

1st-Draw an arc centered in the given point P intersecting the given line in points 1 and 2.
2nd-Draw two arcs with same radius centered in 1 and 2. The two arcs intersect in point 3.
3rd-Connect 3 with the given point. Draw the result with black ink.

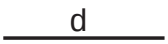


Parallel line to another one through an outer point of the given one:

1st- Draw half circle, through the given point P, with center on the given line. This intersects the given line in point 1 and 2.
2nd- with radius 1P draw and arc centered in point 2 intersecting the circle in point 3.
3rd- Connect 3 with P. Draw the result with black ink.

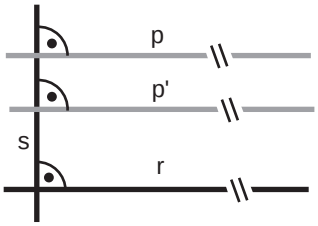


Parallel to a given line at a given distance (d):

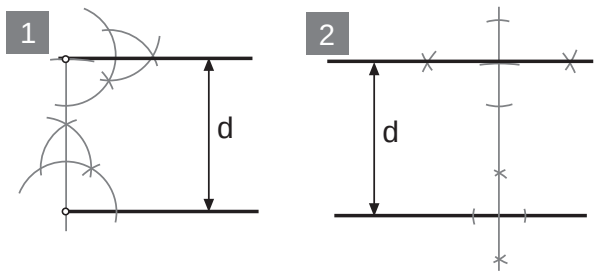


The distance between two lines is the length of a line segment perpendicular to both given lines.

If we have a given line (r), and a perpendicular to it (s), any perpendicular (p) to s will be parallel to s.

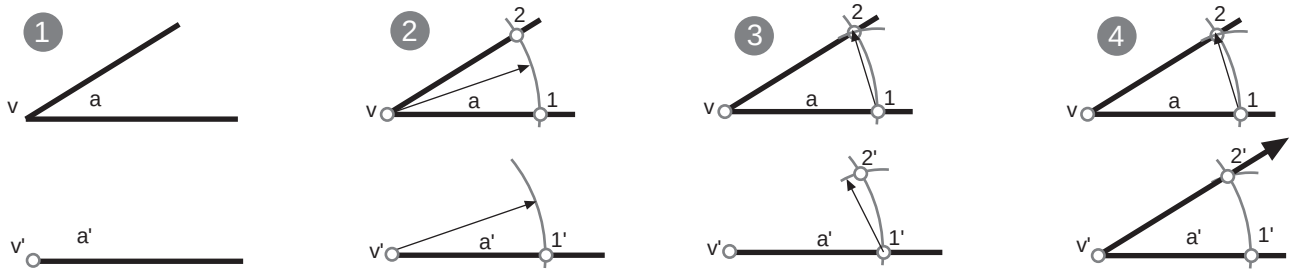


Therefore we can use any of the "perpendicularity" methods to solve this problem. To the right we are showing two of them.



ANGLES COPYING WITH RULER AND COMPASS:
Given an angle (a) draw another (a') equal to the first one.

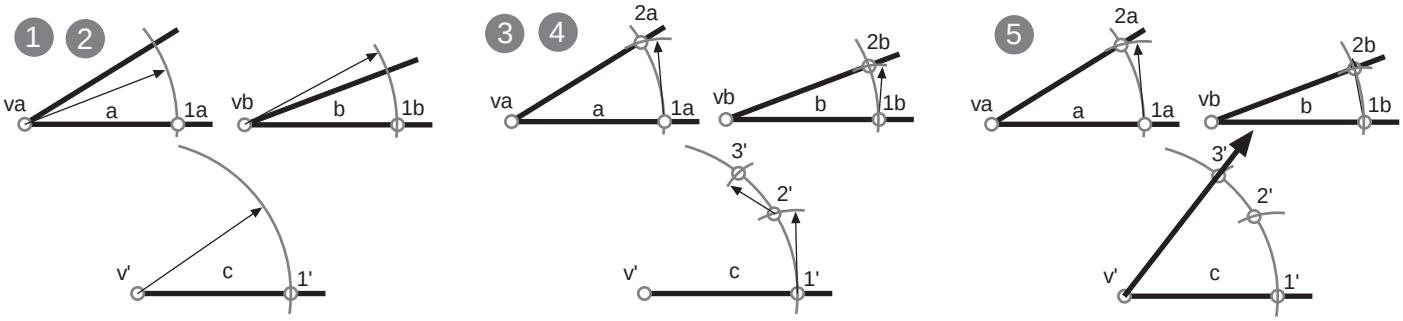
1st- Draw a ray and label the new vertex (the ray's endpoint) as v'.
2nd- Draw an arc centered in v cutting the two rays of an angle in 1 and 2. Centered in v', draw another arc with the same radius to the first one intersecting the ray in 1'.
3rd-Draw and arc centered in 1' with a radius 1-2 intersecting the first arc in point 2'.
4º- Connect v' with 2'. Draw the result with black ink.



ANGLES ADITION WITH RULER AND COMPASS: Given the angles (a) and (b) draw another angle (c)=(a)+(b)

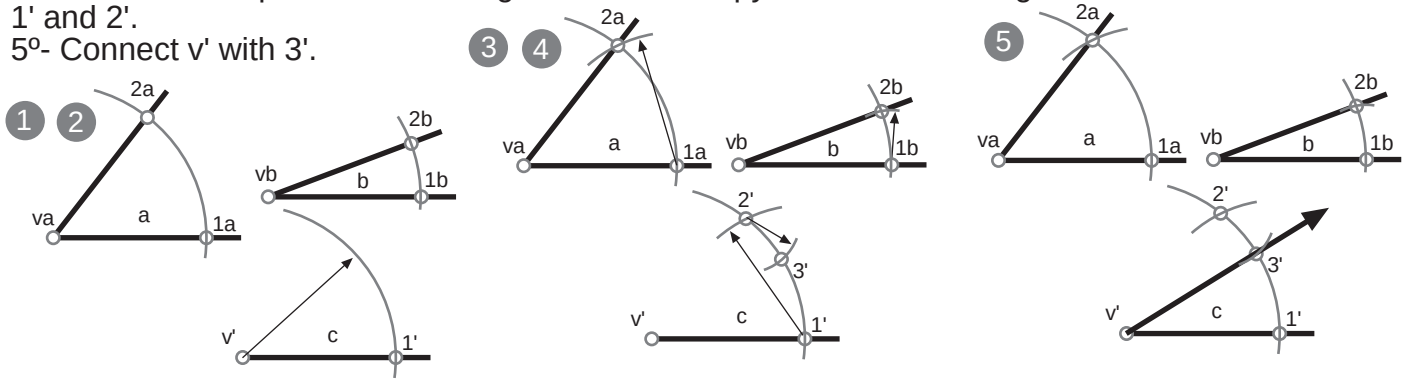
This is about copying one angle and copying the second one right on the upper ray of the first one, Both together are the result.

1st- Draw a ray and label the endpoint as v' which will be the vertex of the result a+b.
2nd- Draw arcs with the same radius centered in (va) y (vb) obtaining 1a and 1b. Draw another arc with the same radius centered in v' obtaining 1'.
3rd- with the compass take the length 1a-2a and draw an arc with that radius centered in 1' obtaining 2'.
4th- with the compass take the length 1b-2b and draw an arc with that radius centered in 2' obtaining 3'.
5th- Connect v' with 3'. label the resulting angle a+b=c with black ink.



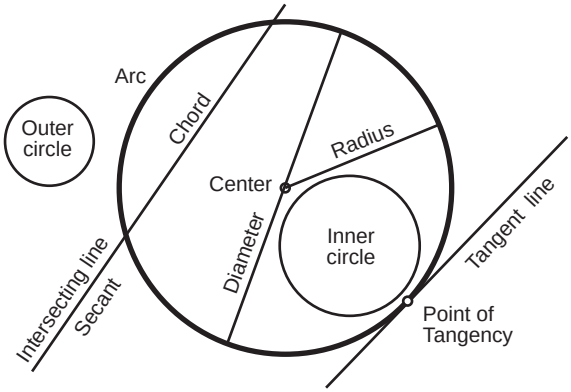
ANGLES SUBTRACTION WITH RULER AND COMPASS: Given the angles (a) and (b) Draw another (c) = (a-b)
Se This is about copying first the bigger angle and copying the smaller inside sharing one ray with the first one, the difference is the result.

1st- Draw a ray and label one endpoint as V' which will be the vertex for the result.
2nd- Centered in (va) and (vb), draw further arcs with any radius but equal, these must intersect both rays of each angle in two points. Centered in v' trace an arc with the same radius obtaining on the v' ray the point 1'.
3rd- With the compass take the length 1a-2a and copy it from 1' obtaining 2'.
4th- With the compass take the length 1b-2b and copy it from 2' obtaining 3' that must be between 1' and 2'.
5º- Connect v' with 3'.



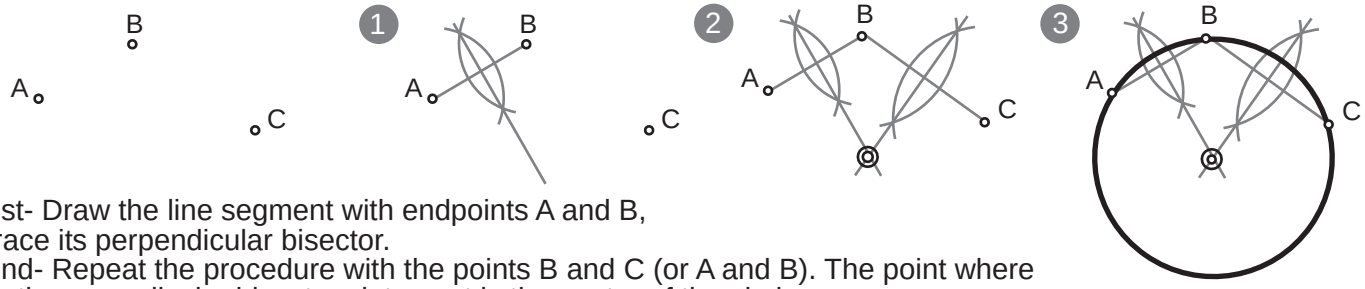
IMPORTANT DEFINITIONS ABOUT CIRCLES:

Circle: Set of points at the same distance (equidistant) to a point called center.
Circumference: It is the full length of a circle.The complete distance around a circle.
Center: It is the point equidistant to any of the points on a circle.
Radius: It is the length of a line segment from the center to its perimeter. (plural Radii from latin or common english radiuses)
Diameter: A line segment that passes through the center and conects two points of a circle. its lengh is double than the radius.



Chord: A line segment which conects two points of the circle not through the center.
Arc: segment of a circle. Watch out!! ARCH is for architecture,
Tangent: Element (straight or curve lines) which touch a circle in one point.
Outer: When an element (line or curve) doesn't touch the circumference, or another element.
Inner: When an element (line or curve) is fitted inside the circumference, or another element, being tangent or not.
Concentric circles: They are circles with diferent radius but place in the plane sharing the center.

Draw a circle through three given points (A, B and C)



1st- Draw the line segment with endpoints A and B, trace its perpendicular bisector.
2nd- Repeat the procedure with the points B and C (or A and B). The point where both perpendicular bisectors intersect is the center of the circle.
4 th-With center in that point and radius to any of the given points, draw the cricumference.

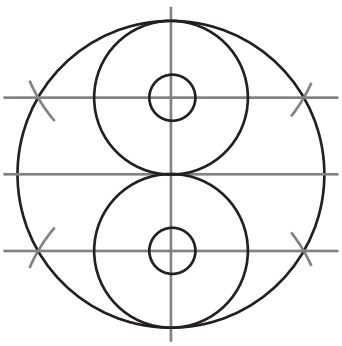
Knowing how to solve this problem we can easily find the center of a circle or an arc by drawing two chords of a circle and finding their perpendicular bisectors. The point where both bisectors intersect is the center of the circle.

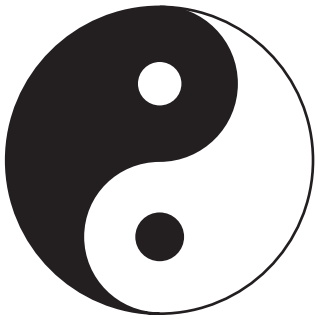
Here you can see an **animation on how to find the center of an arc.**
http://www.mathopenref.com/constcirclecenter.html

LANGUAGE. FALSE FRIENDS: CIRCLE-CIRCUNFERENCE

Watch **this video about language and notations of the circle** it will take you ten minutes.
http://youtu.be/U2W7HPyC0cM

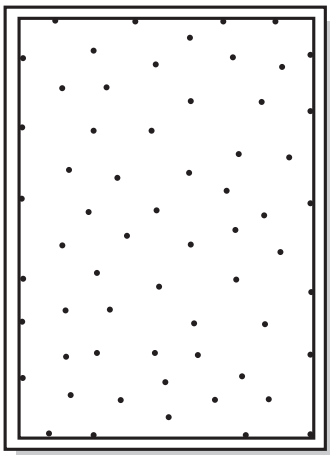
"circunferencia" is translated into English as **"circle"** **"circumference"** in English mean**s "the perimeter of the circle"** There is no word in Spanish for **"circumference"** so in spanish it is said **"perímetro o longitud de la circunferencia".** As well as there is no word for **"círculo"** in English which is called **"area of a circle"**

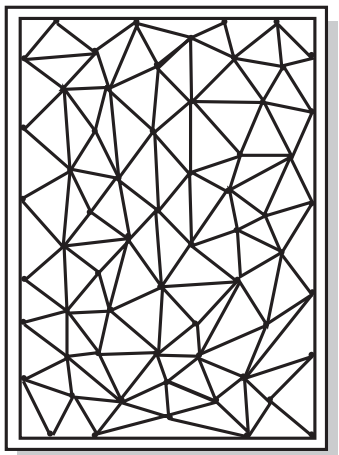




Bearing.
Source: http://www.bearings-china.com/

TRIANGLES AND PARALLELS





1st- Draw dots spread all over the worksheet. Don't arrange them in a tidy way. DO NOT forget to draw some dots on the edges of the frame.

2nd- Connect each dot with the closer ones with a ruler.

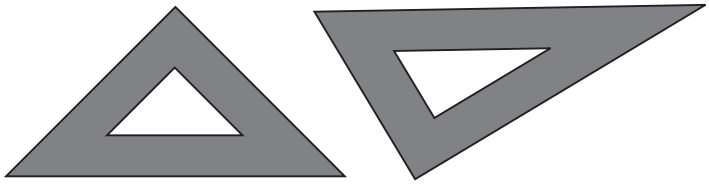
- The line segments conecting the dots cannot cross other line segments conecting other dots. If you let that happen the resulting triangles will be smaller than supposed.
- The line segments connecting dots cannot go through other dots.
- That is to say: each line segment only has two end points and no midpoints and does not intersect any other line segment.
- DO NOT forguet to connect the dots on the edges with other dots.

3rd- If you follow correctly these two first steps you will have completed the worksheet with triangles.

4th- You must fill in with color markers each triangle with parallels using the set squares:

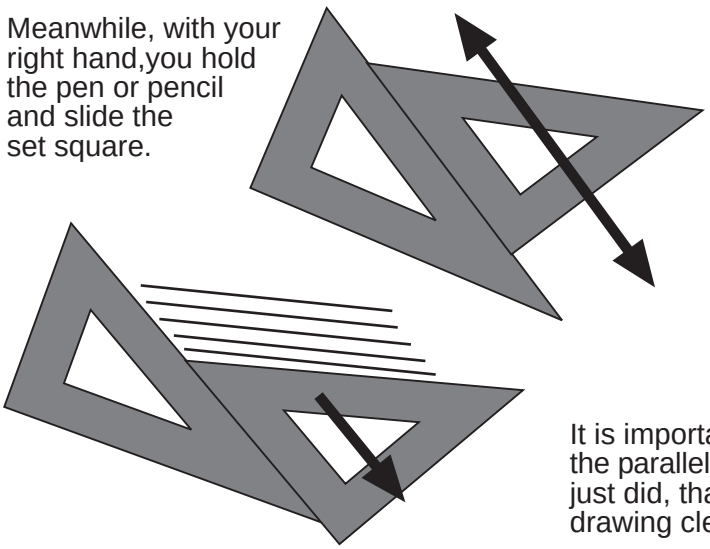
-**Triangles sharing sides or edges CANNOT contain the same color, neither the same slope or frequency of parallels. Each triangle only has to contain one color for its parallels**.
-You need to complete every triangle with parallels.
- It will always be better that you try to complete a design of something you think that can be abstract or figurative rather that asign colors randomly.

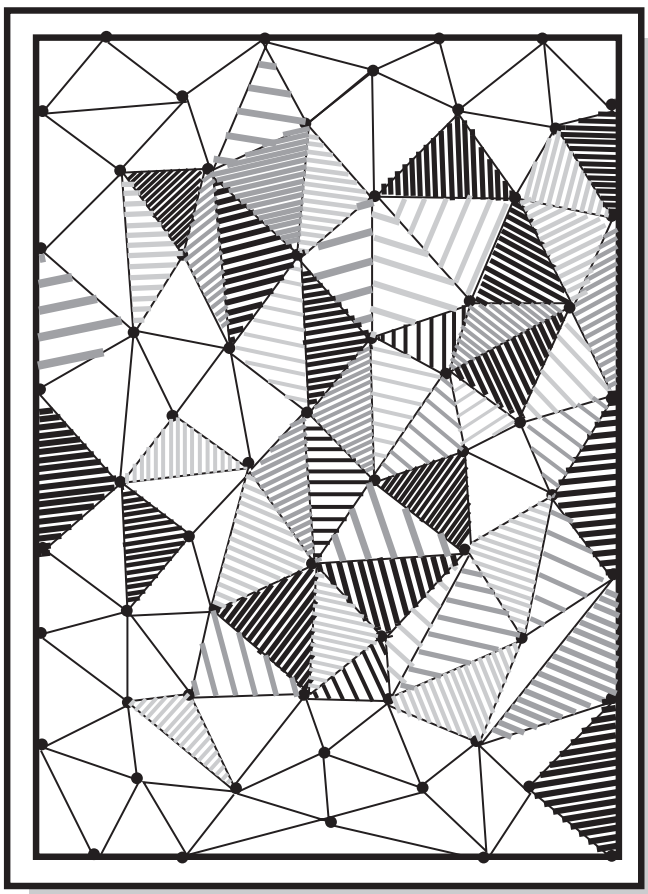
USING THE SET SQUARES TO DRAW PARALLEL LINES



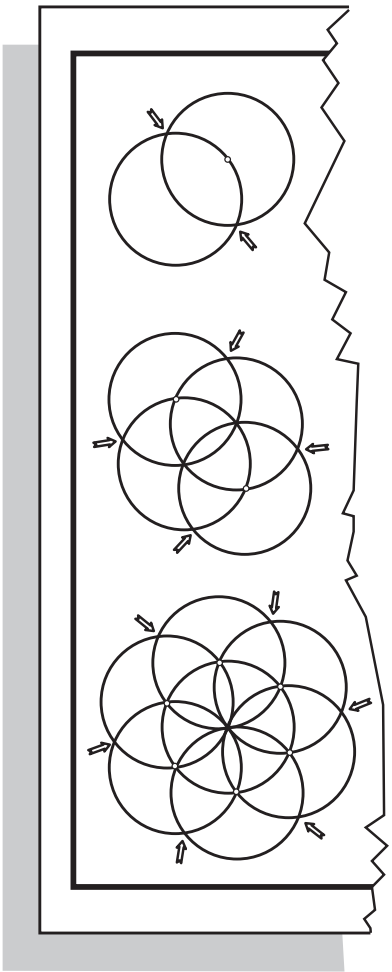
Use your "wrong hand" (left hand if you are right handed) to hold tight one of the set squares against the paper sheet. This set square must be static and cannot move under any concept. With that hand, with your index finger, hold the other set square as a break so it does not move while you draw the lines with your other hand.

Meanwhile, with your right hand,you hold the pen or pencil and slide the set square.





It is important that you slide the moving set square as you leave the parallel lines behind so you don't "step over" the parallels you just did, that way you will not mess up with fresh ink leaving the drawing clearer and neat.

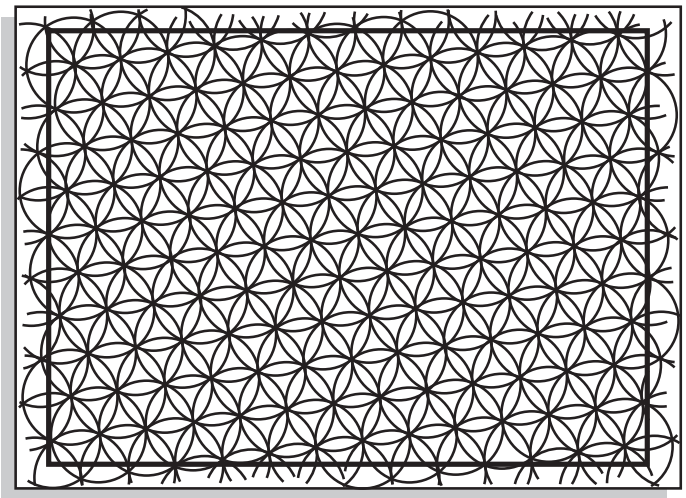


CIRCLES PATTERN 1

This worksheet is about filling in the drawing space with circles with the same radius (2'5 cm.). But you must do it following a simple pattern:

1st- Draw a circle (with a radius of 2,5 cm) centered in any place in the worksheet. It is better that you place it in the middle.
2nd- Draw another circcle, with the same radius, centered in any of the points of the first circle you did.
3rd- The two intersecting points of both circles are new centers for new circles with the same radii. These will intersect in four new points to center new circles.

4th- As you keep on drawing circles you will obtain new intersecting points to center new circles. Remember all the circles must have the same radius!!
5th- Fill in all the worksheet. Draw also circles even out of the frame, since those might intersect and show you a center for a circle which part of it is inside the frame.
6th- Erase anything out of the frame.
7th- GIVE COLOR TO ALL THE WORKSHEET: IFollow a pattern for color. For instance, you can give the "petals" one or two colors (following a pattern) and do the same for the "curved triangles":



IMPORTANT WARNING: You must keep the lead of the compass very sharp. It is very important that you keep the same radius all the time and that you set the center accurately. If you have tried hard and couldn'tn make it try it with 3cm. radius circles.

FLATLAND - Edwin A. Abbott 1838-1926

Watch this **movie trailer of a cartoon version of flatland.** It is subtitled in Spanish
http://youtu.be/7l4ZHwodLQA

1. OF THE NATURE OF FLATLAND

I call our world Flatland, not because we call it so, but to make its nature clearer to you, my happy readers, who are privileged to live in Space.

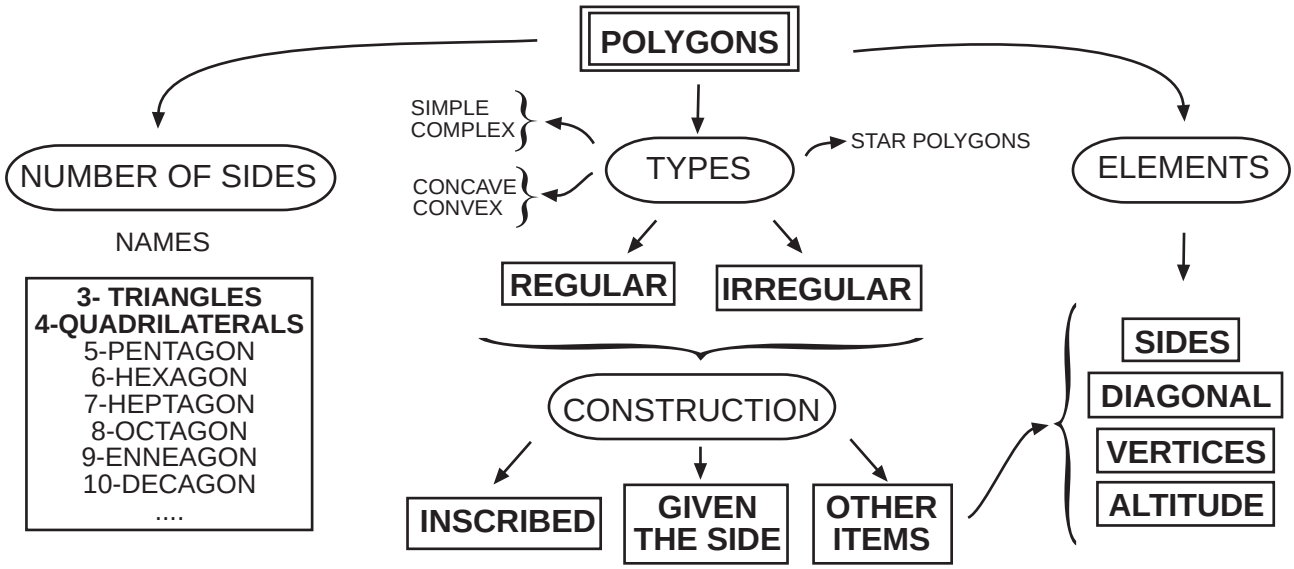
Imagine a vast sheet of paper on which straight Lines, Triangles, Squares, Pentagons, Hexagons, and other figures, instead of remaining fixed in their places, move freely about, on or in the surface, but without the power of rising above or sinking below it, very much like shadows--only hard with luminous edges--and you will then have a pretty correct notion of my country and countrymen...

2. OF THE CLIMATE AND HOUSES IN FLATLAND

As with you, so also with us, there are four points of the compass North, South, East, and West.

There being no sun nor other heavenly bodies, it is impossible for us to determine the North in the usual way; but we have a method of our own...

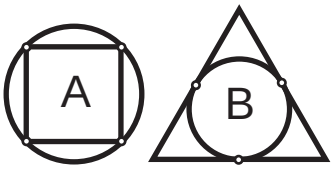
....Square and triangular houses are not allowed, and for this reason. The angles of a Square (and still more those of an equilateral Triangle,) being much more pointed than those of a Pentagon, and the lines of inanimate objects (such as houses) being dimmer than the lines of Men and Women, it follows that there is no little danger least the points of a square of triangular house residence might do serious injury to an inconsiderate or perhaps absentminded traveler suddenly running against them: and therefore, as early as the eleventh century of our era, triangular houses were universally forbidden by Law, the only exceptions being fortifications, powder-magazines, barracks, and other state buildings, which is not desirable that the general public should approach without circumspection...



Star polygons: It is a particular polygon case with a star shape, created out of linking together non consecutive vertices of a regular polygon.

INSCRIBED VERSUS CIRCUMSCRIBED:

Inscribed Polygons: They are polygons placed inside circles so all the vertices of the polygon are placed on the circle.
Circumscribed polygons: They are polygons surrounding a circle, being its sides tangent to the circle inside.



A- The square is inscribed in the circle while the circle is circunscribed to the square.

B- The circle is inscribed in the triangle while the triangle is circumscribed to the triangle.

Watch this short **Youtube video** that introduces you the polygons definition and some names

http://youtu.be/LfPDFGvGbqk

FLATLAND - Edwin A. Abbott 1838-1926

3. CONCERNING THE INHABITANTS OF FLATLAND

The greatest length or breadth of a full grown inhabitant of Flatland may be estimated at about eleven of your inches. Twelve inches may be regarded as a maximum.

Our Women are Straight Lines.

Our Soldiers and Lowest Class of Workmen are Triangles with two equal sides, each about eleven inches long, and a base or third side so short (often not exceeding half an inch) that they form at their vertices a very sharp and formidable angle. Indeed when their bases are of the most degraded type (not more than the eighth part of an inch in size), they can hardly be distinguished from Straight lines or Women; so extremely pointed are their vertices. With us, as with you, these Triangles are distinguished from others by being called Isosceles; and by this name I shall refer to them in the following pages.

Our Middle Class consists of Equilateral or Equal-Sided Triangles.

Our Professional Men and Gentlemen are Squares (to which class I myself belong) and Five-Sided Figures or Pentagons.

Next above these come the Nobility, of whom there are several degrees, beginning at Six-Sided Figures, or Hexagons, and from thence rising in the number of their sides till they receive the honorable title of Polygonal, or many-Sided. Finally when the number of the sides becomes so numerous, and the sides themselves so small, that the figure cannot be distinguished from a circle, he is included in the Circular or Priestly order; and this is the highest class of all...

5. OF OUR METHODS OF RECOGNIZING ONE ANOTHER

You, who are blessed with shade as well as light. You, who are gifted with two eyes, endowed with a knowledge of perspective, and charmed with the enjoyment of various colors. You, who can actually SEE an angle, and contemplate the complete circumference of a Circle in the happy region of the Three Dimensions--how shall I make it clear to you the extreme difficulty which we in Flatland experience in recognizing one another's configuration?

Recall what I told you above. All beings in Flatland, animate and inanimate, no matter what their form, present TO OUR VIEW the same, or nearly the same, appearance, viz. that of a straight Line. How then can one be distinguished from another, where all appear the same?...

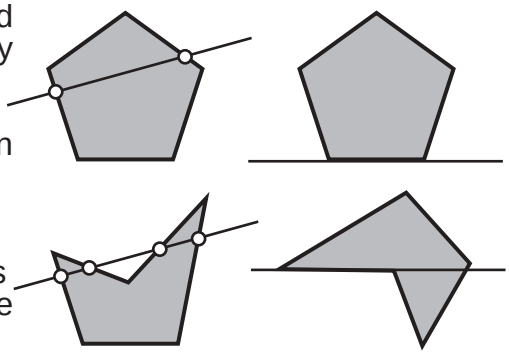
POLYGONS

A polygon is a number of coplanar line segments (called **edges** or **sides**), each connected end to end (**Vertex**/**vertices**)to form a closed shape. The word "polygon" derives from the Greek (polús) "several" and (gonía) "angle".

CLASSIFICATIONS

Convex polygon: Any line drawn through the polygon (and not tangent to an edge or corner) meets its boundary exactly twice. As a consequence, all its interior angles are less than 180°. Equivalently, any line segment with endpoints on the boundary passes through only interior points between its endpoints.

Non-Convex polygon (concave): a line may be found which meets its boundary more than twice. Equivalently, there exists a line segment between two boundary points that passes outside the polygon. There is an interior angle greater than 180°.



Equiangular: all their corner, angles or vertices are equal.
Equilateral: all edges or sides are of the same length.
Regular: All their vertices angles and sides are equal.
Irregular: Show different angles and lengths for their sides.

Play with the polygon vertices in **this website** to observe how the type name changes.

http://www.mathopenref.com/polygon.html

NAME OF POLYGONS ACCORDING TO THE NUMBER OF SIDES

3	Triangle	12	Dodecagon
4	Quadrilateral	13	Triskaidecagon
5	Pentagon	14	Tetradecagon
6	Hexagon	15	Pentadecagon
7	Heptagon	16	Hexadecagon
8	Octagono	17	Heptadecagon
9	Enneagon / Nonagon	18	Octadecagon
10	Decagon	19	Eneadecagon
11	Hendecagon		

TENS		AND	ONES			OTHER	
20	Icosa-	kay	1	-hena-	-gon	100	Hectgon / Hectagon
30	Triaconta-		2	-di-		1000	Chiliagon
40	Tetraconta-		3	-tri-		10000	Myriagon
50	Pentaconta-		4	-tetra-			
60	Hexaconta-		5	-penta-			
70	Heptaconta-		6	-hexa-			
80	Octaconta-		7	-hepta-			
90	Enneaconta- or Nonaconta-		8	-octa-			
			9	-ennea- / -nona-			

POLYGONS PARTS

SIDE OR **EDGE**: Each of the line segments that form a polygon.

VERTEX (**vertices**, plural): The point in which two sides or edges meet.

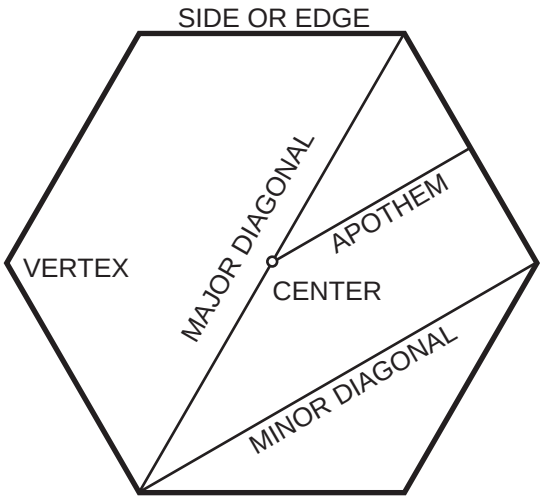
DIAGONAL: Segment line that connects non consecutive vertices. Some polygons have a major diagonal and a minor diagonal.

PERIMETER: The path around a polygon, the addition of all its sides.

In a regular polygon we can also find:

CENTER: A point equidistant from all the vertices. It is the center for the inscribed and circunscribed circle (only in regular polygons) .

APOTHEM: line segment from the center to the midpoint of one of its sides..



Play with the polygon vertices and take a look to **this website** to learn more about regular polygons.

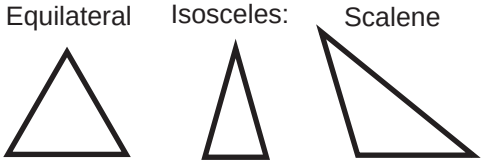
http://www.mathopenref.com/polygonregular.html

IMPORTANT DEFINITIONS AND CLASSIFICATIONS ABOUT TRIANGLES:

Triangle: It is a flat figure with three sides and three angles.

ACCORDING TO THE SIDES:

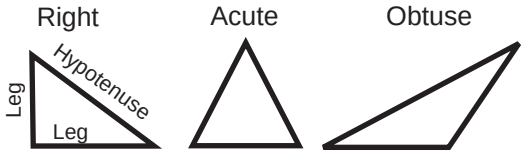
Equilateral Isosceles: Scalene



Equilateral triangle: It is a triangle which sides and vertices are the same.
Isosceles triangle: It is a triangle which has two equal sides and angles.
Scalene triangle: It is a triangle which has three different sides and angles.

ACCORDING TO THE ANGLES:

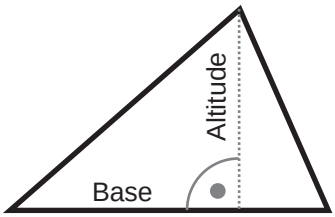
Right Acute Obtuse



Right triangle: It is a triangle which has one right angle. The side opposite to the right angle is called **hypotenuse** and the sides adjacent to it are called **legs**. .
Obtuse: Obtuse triangles have one angle which is more than 90º .
Acute: All their vertices are acute.

Watch this **Youtube video** to listen an explanations of triangles classifications.

http://youtu.be/Bb8e3ZkU3Sw



To learn more about triangles check **this animated and interactive website** which tells us more definitions and constructions.

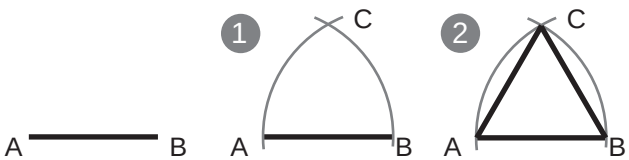
http://www.mathopenref.com/triangle.html

COMPLETE THE GAPS WITH THE GIVEN WORDS BELOW:

Segments-Polygon- Closed-Base-Vertices- Altitude

A triangle is a _____ shape consisting in three line_____ linked end-to-end, so it has three _____. It is a 3 sided _____. The _____ can be any of its three sides, but it is ususally drawn at the bottom. The _____ of a triangle is the distance from the base to the opposite vertex.

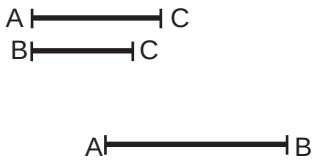
Regular triangle construction known its side



1st- Trace two arcs centered in the end points of the given segment with radius equal to the side. The point where the arcs intersect is the vertex C.

2nd- Connect the points A and B with C to obtain the equilateral triangle.

Scalene triangle construction known its three sides:

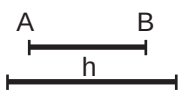


1st- With your compass take a radius equal to the segment AC, and centered in the A end point of AB trace an arc

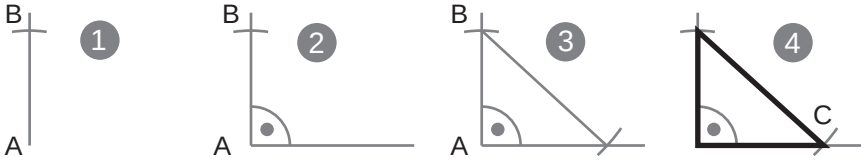
2nd- With your compass take ta radius equal to the segment BC, and centered in the B end point of AB trace another arc that intersects the first one in a point C.

3rd- Conect A and B with C to get the scalene triangle drawn.

Right triangle construction known one of its legs AB and its hypotenuse h



1st- Copy the segment line AB, which is the given leg's length.



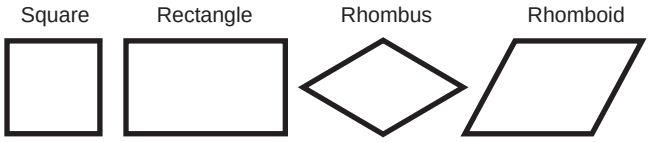
2nd- With the set squares or triangles, trace a perpendicular to AB segment from the A end point.
3rd- With radius equal to the hypotenuse and centered in B end point, trace an arc which intersects the perpendicular to AB in a C point.
4th-Conect the three points: A, B and C to obtain the right triangle.

IMPORTANT DEFINITIONS ABOUT QUADRILATERALS:

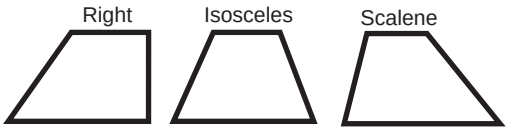
Quadrilateral: They are polygons with four sides and four vertices.

PARALLELOGRAMS: They are quadrilaterals with two pairs of parallel opposite equal sides and and two pairs of opposite equal angles. Their diagonals bisect each other.

Square: Quadrilateral with the same dimensions for all their four sides and with four right angles.
Rectangle: It is a parallelogram with two pairs of equal sides and four right angles.
Rhombus: It is a parallelogram with four equal sides and two pairs of equal angles.
Rhomboid: It is a parallelogram with two pairs of equal sides and two pairs of equal angles.

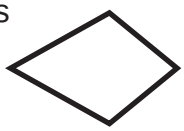


TRAPEZIUMS: Only one pair of sides are paralel.

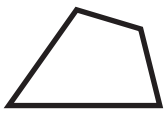


Right trapezium: It is a trapezium which has a right angle.
Isosceles trapezium: It is a trapezium which has two equal sides and two pairs of equal angles.
Scalene trapezium: It is a trapezium which has three different sides and vertices.

KITES: Two pairs of equal sides which are adyacent, one pair of equal angles,but no sides are parallel.



TRAPEZOIDS OR IRREGULAR QUADRILATERALS: No sides are parallel and have no equal sides.



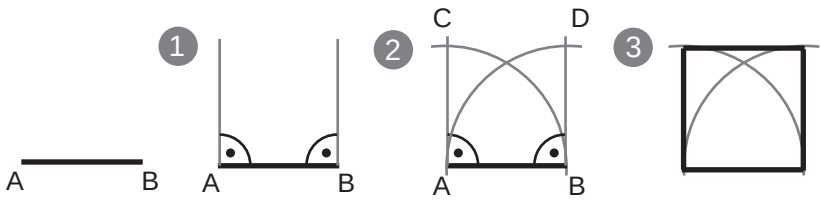
!! **LANGUAGE WARNING**: **These are the names for British English**. In American English Quadrilaterals with one pair of parallel sides are called "Trapezoids", while the Quadrilaterals with no parallel sides are called "Trapeziums". British names are more similar to the names in Spanish

So we chose to explain in this notes the British way because its names are more similar to our Spanish names. That's what you have to study and learn. However, on the right you can see a serious American website that explains both way and a funny American song which is not even totally correct with its classsifications names.

To learn more about quadrilaterals check **this animated and interactive website** which tells us more definitions and constructions.
http://www.mathopenref.com/quadrilateral.html

Listen to this **youtube videoclip** telling us about quadrilaterals AND FIND THE WRONG NAME for one of the polygons they explain.
http://youtu.be/k7oLm94kQEE

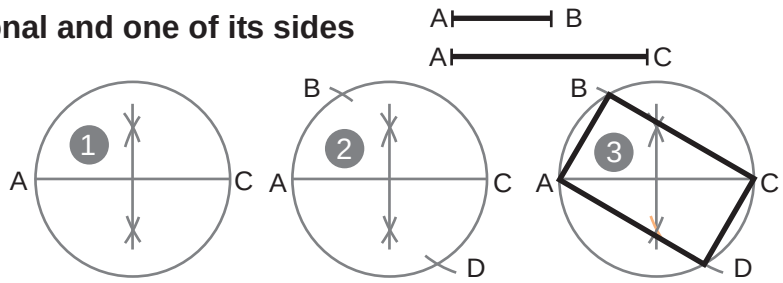
Square construction known its side dimension



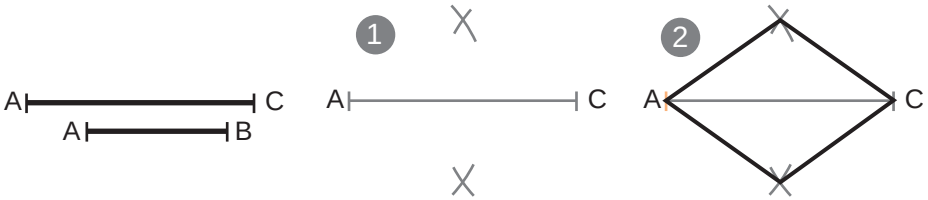
1st- Trace two perpendicular segments from both endpoints A and B.
2nd- Centered in A and B endpoints, trace two arcs which radius is equal AB. On both perpendicular segments you will obtain vertices C and D.
3rd- Connect the four points A, B, C and D together to obtain the square.

Rectangle construction known the diagonal and one of its sides

1st- Trace the diagonal AC and centered in it's midpoint O, draw a circle with an O-C radius.
2nd- Centered in A and C, trace two arcs with a radius equal to the given side. They will intersect the circle in B and D
3rd- Connect the four points A, B, C and D to obtain the rectangle.



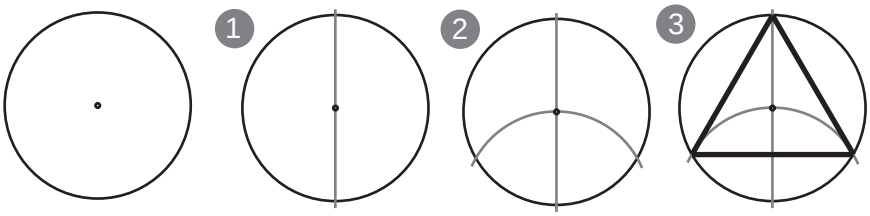
Rhombus construction known the diagonal and the sides



1st- With an AB radius, centered on the AC endpoints trace two arcs above and below the segment . The two points where the arcs intersect are the points B and D
2nd- Connect the four points A, B, C and D together to obtain the rhombus.

Given the circunscribed circles, Regular polygons constructions:

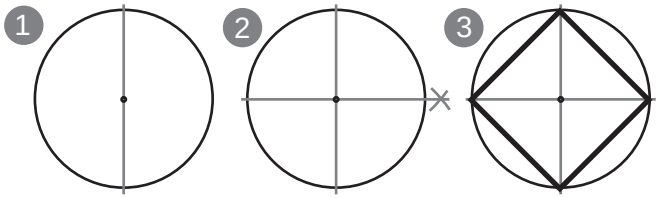
Equilateral triangle:



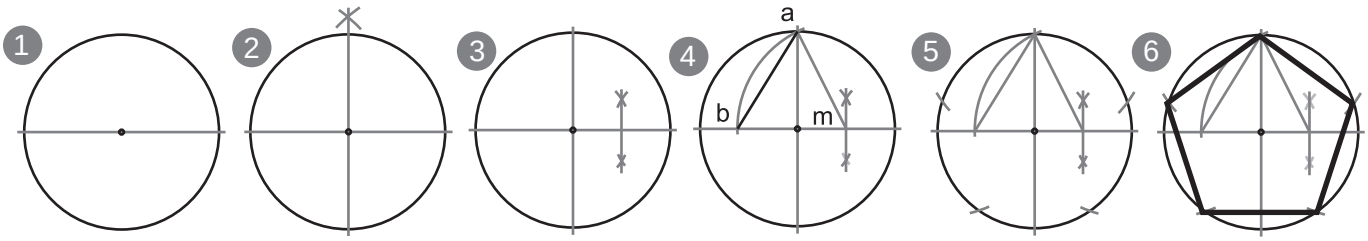
1st- Trace a vertical diameter
2nd- Centered in one of the diameter's endpoints and with a radius equal to it draw an arc that intersects the circle in two points.
3º- Connect the two points together and with the other diameter's endpoint.

Square

1st- Trace a diameter.
2nd- Trace a perpendicular diameter to the first one.
3rd- Conect the four diameters' endppoints.

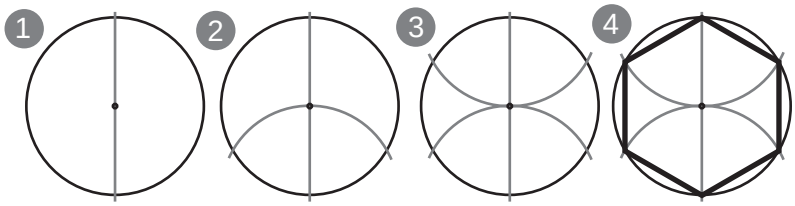


Pentagon



1st- Trace a diameter. 2nd- Traze a perpendicular diameter to the first one. 3rd- Draw the perpendicular segment bisector toone of the radii shown by the two diameters, obtaining point m. 4th- Centered in m and a radius radio m-a traze an arc to obtain b => a-b is the dimension of the side for the inscribed pentagon. 5th- With a radius a-b, starting by "a", traze five arcs intersecting the circle 6th- Conect the points on the circle.

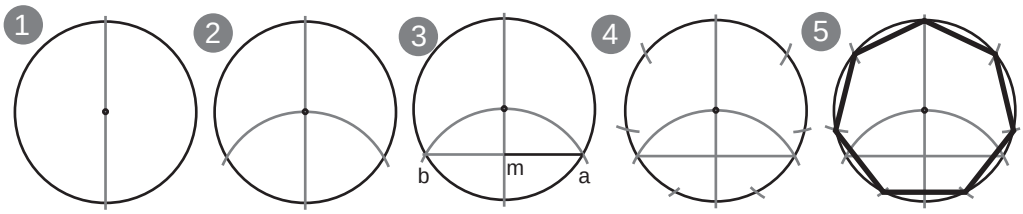
Hexagon



1st- Trace a vertical diameter.
2nd- Centered in adiameter's endpoint draw an arc, with a radius equal to the circle's, intersecting it in two points.
3th- Centered in the other endpoint repeat the last step.
4º- Connect the six points on the circle.

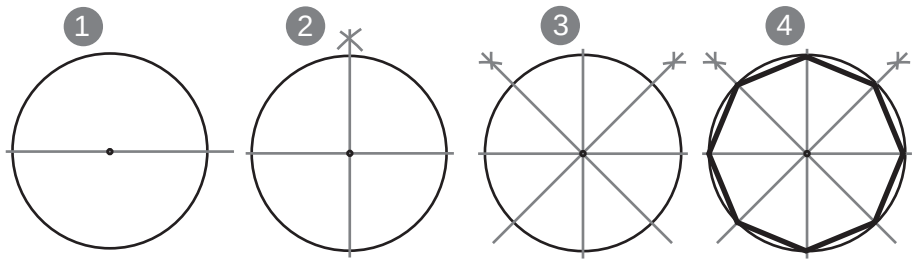
Heptagon

1st- Trace a vertical diameter.
2nd- Centered in adiameter's endpoint draw an arc, with a radius equal to the circle's, intersecting it in two points, a and b.
3rd- Connect a with b obtaining m. a-m is the dimension of the side for the inscribed heptagon.



4th- Trace arcs, centered on the circle and with a radius a-m, to obtain the circle division.
5th- Connect the points on the circle.

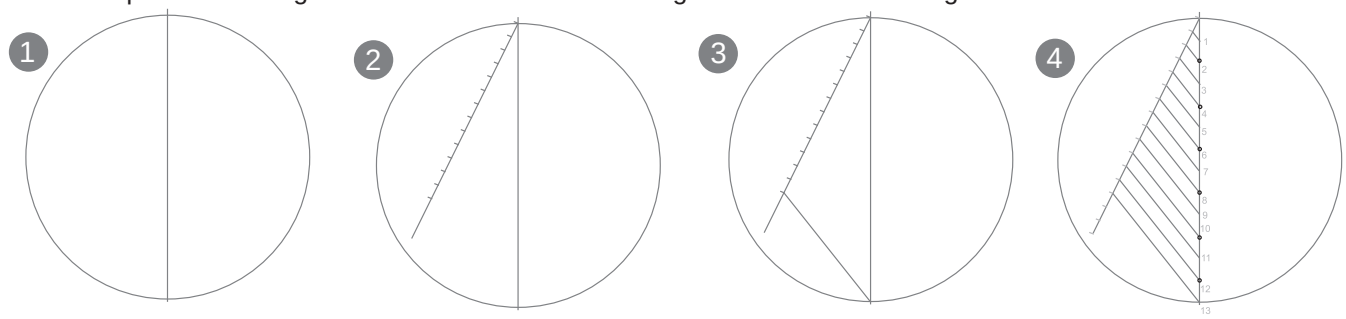
Octagon



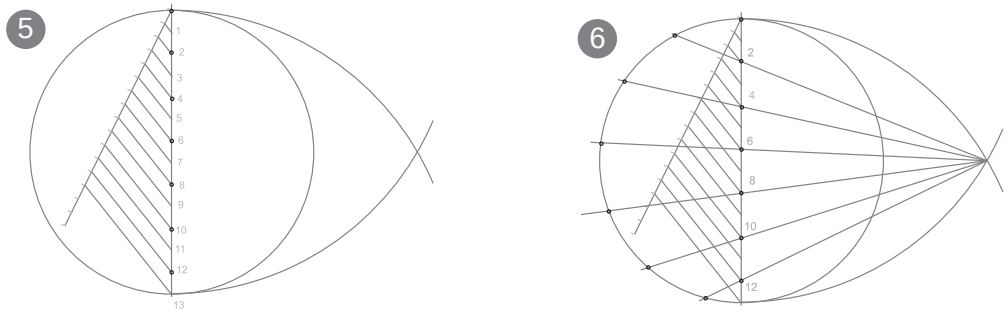
1st- Trace a horizontal diameter.
2nd- Trace a perpendicular diameter to the first one .
3rd- Trace angle bisectors (2 are enough) to the four quadrants.
4th- Connect the eight points on the circle.

Given the circumscribed circle radius a: Draw a n sided (13) regular polygon: _____

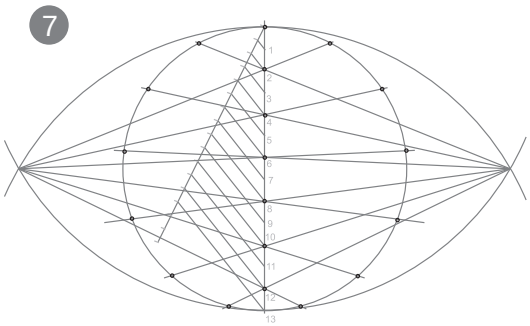
1th- Trace a circle with the given radius lengh, Trace a vertical diameter:
DIVIDE THE DIAMETER INTO AS MANY PORTIONS AS AIMED SIDES FOR THE POLYGON WANTED
2nd- Trace an auxiliary segment forming any angle with the vertex in the top diameter's endpoint and divide it into as many portions as wanted portions for the diameter (you can use either a ruler or the compas)
3rd- Connect the last auxiliary segment's mark with the bottom diameter's endpoint.
4th- Trace parallels through the division marks intersecting the diameter obtaining the divisions wanted on it.



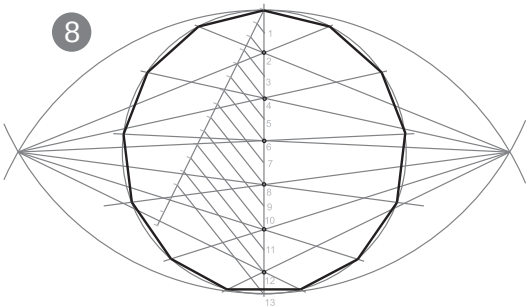
5th- Centered in the diameter's endpoints and radius equal to it trace two arcs in which both intersections we will find two focii (one focus in each intersection).
6th- From one focus we trace rays through the even divisions on the diameter to intersect the circle in two points every ray. These rays project on the circle half of the divisions in their outgoing intersections with the circumference. Division 0, on the diameter also must be included, even though we did't need to project a ray due to its position on the circle.

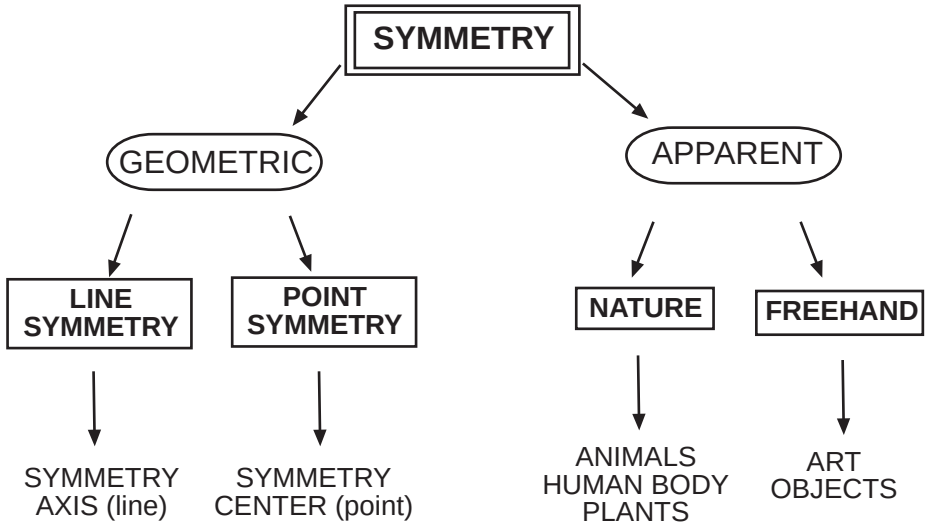


7th- Repeat the last step, this time in the opposite side.



8th- Conect all the points obtained on the circle. Remember to conect also number 0 on the top of the diameter.





Learn many aspects about symmetry and read some definitions in this **Math is fun symmetry section**

http://www.mathsisfun.com/geometry/symmetry.html

Watch this short **Youtube video** that introduces you to symmetry in life and nature

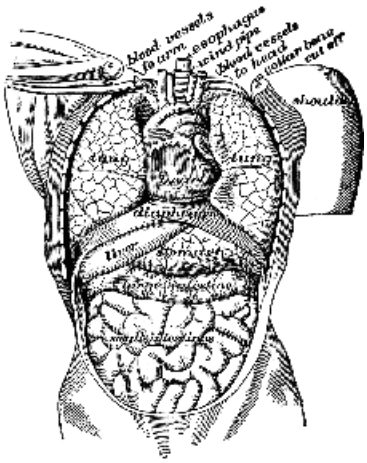
http://youtu.be/TldmWSbOvM0

IMPORTANT DEFINITIONS RELATED TO SYMMETRY

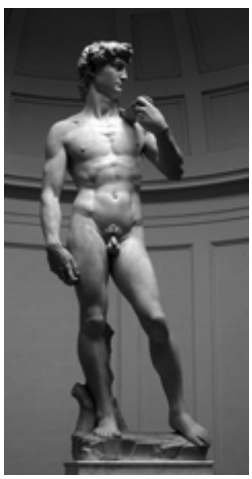
Symmetry: It is a quality of some shapes which some of their parts are reflections of others.
Reflection symmetry (line symmetry): It is a shape's quality which is formed by two halves facing each other with an axis or fold line in between as if both sides were mirror images of each other.
Symmetry axis (also symmetry line): It is a line which divides a shape into two symmetric halves. Every element of the shape is reflected on the other side and at the same distance from the axis (fold line). Symmetric points are on a perpendicular line to it.
Central symmetry (also point symmetry): It is the reflection of an object through a point called the symmetry center (or symmetry point). Every symmetric point is on the other side and at the same distance from the center of symmetry. Symmetric pair of points are collinear with the center.
Geometric symmetry: It is a kind of symmetry which follows accurately the geometric symmetry rules.
Apparent symmetry: It is the quality of shapes or objects which show an obvious symmetry, but not every point or element follows accurately the geometric symmetry rules. It happens very frequently in nature.
Symmetrical balance: It is a way to organize parts of an image, picture or drawing so one side duplicates or mirrors the other. The opposite way is called Asymmetrycal balance.

SYMMETRY AXIS (SYMMETRY LINE)

There is an international standarization to represent the symmetry axis in technical drawings and plans, so they are drawn with short traces alternating with dots. This way whoever that sees a plan or a drawing can be aware of that line representing the symmetry of the drawing.



Organs of the human cavity.
Source:http://etc.usf.edu/clipart/22100/22141/bdycavorgans_22141.htm



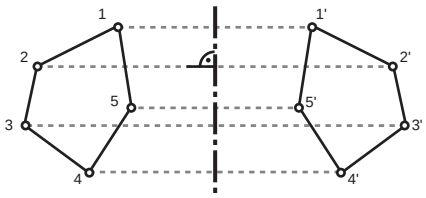
David.Michellangello Buonaroti
Source:http://www.leslieparke.com/2011/01/michelangelo-revealed/

Tree Silhouette.Keith Evans
Source:http://www.geograph.org.uk/photo/2274631

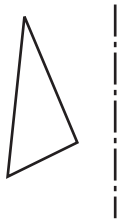
SYMMETRY AND ASYMMETRY IN NATURE

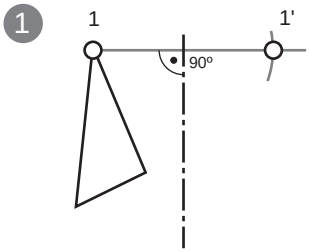
Somehow symmetry is the beauty expression for nature. Animals, humans and plants are symetrical in the outside but mostly asymmetrical in their inside.

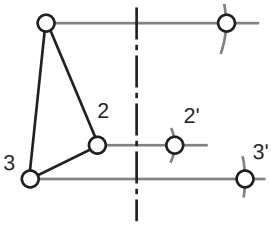
REFLECTION SYMMETRY (Axial Symmetry or line symmetry): Pairs of symmetrical points are located on a perpendicular line to the symmetry axis or fold line, at the same distance from it but on opposite side. Some objects or shapes are just symmetrical on their own. That is to say, half of the figure is a mirror image of the other half.

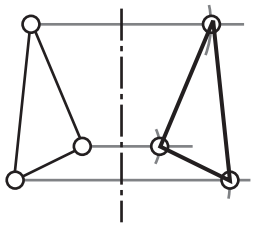


How to draw a symmetrical triangle over an axis or line of symmetry .









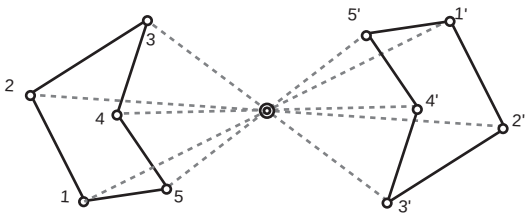
1st- Make a perpendicular line to the axis from one vertex to the other side of it. With the compass, take the dimension from the vertex to the intersection of the line with the axis and copy it on the perpendicular line but on the other side.
2nd-Repeat the procedure with the other two vertices of the triangle.
3nd-Connect the three symmetrical vertices with three segments.

Learn about lines of symmetry and drawing a symmetric figure in this **Youtube video**

http://youtu.be/wLIY8HwmjxE

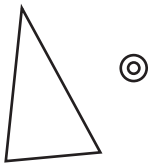
CENTRAL SYMMETRY or POINT SYMMETRY: Symmetric points are colinear (on the same line) with the symmetry center, at the same distance and on opposite side from it.

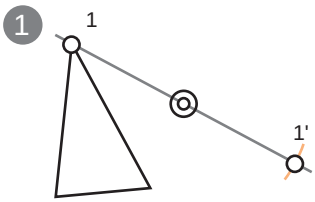
Here you'll learn how to Draw a symmetrical figure using compass and ruler or straight edge.

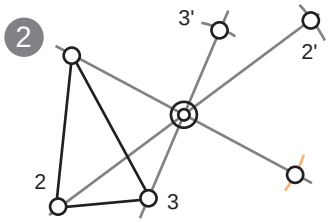


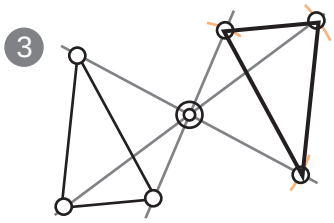
A central symmetrical shape is the same than rotating the original shape 180º.

How to trace a symmetrical triangle over a symmetry center:





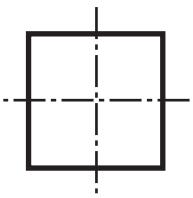




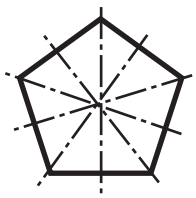
1st- Make a line from one vertex through the symmetry center. With the compass, take the dimenssion from the center to the vertex and copy that distance on the other side of the center on the perpendicular line. Therefore we have one symmetrical vertex of one pair of symmetrical points.
2nd-Repeat the procedure with the other two vertices of the triangle.
3nd-Connect the three symmetrical vertices with three segments.

Symmetry order of a shape:

When a figure matches with more than one symmetry line; that is the same than saying: when we can draw more than one fold line for the same shape. Then we say it has a symmetry order of the number of symmetry lines that can be drawn. Also, those figures, can be rotated a number of times showing the same shape than the original as many times as fold lines can hold.
So a square has a symmetry order of four, or four fold symmetries, A regular pentagon has a five fold symmetry, etc.



2 fold symmetry



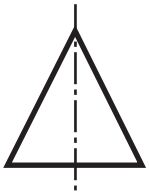
5 fold symmetry

here you can watch a **Youtube video** explaining the concept of "order of symmetry

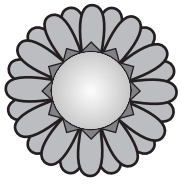
http://youtu.be/h-EBCSf8o4c

Play this **interactive online game** in which they'll ask you about symmetry lines of geometic shapes

http://www.innovationslearning.co.uk/subjects/maths/activities/year3/symmetry/shape_game.asp



1 fold symmetry



12 fold symmetry

So, as you can see, architecture uses both types of symmetry (line and point symmetry).Following you can see three pictures. These are all Gothic architecture elements such as a Rose window or two Porticos.

Look at them carefully, identify which type of both symmetries each picture has. And find the hidden asymmetry.

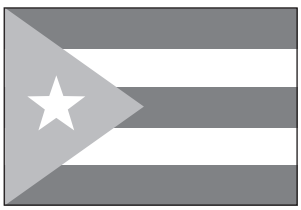
Sto. Domingo de Soria. Rose window
Source: http://commons.wikimedia.org/

Apostoles Portico. Valencia's Cathedral
Source:http://www.jdiezarnal.com/

Sta Maria de Requena. Portico
Source: laslaminas.es

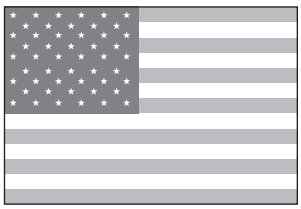
Now you are going to check some flags of the world symmetries. They may have one axis symmetry, two axis symmetries or none (asymmetrical). If they have any symmetries draw the axis on it:

SYMMETRIC ☐ ASYMMETRIC ☐



CUBA

SYMMETRIC ☐ ASYMMETRIC ☐



USA

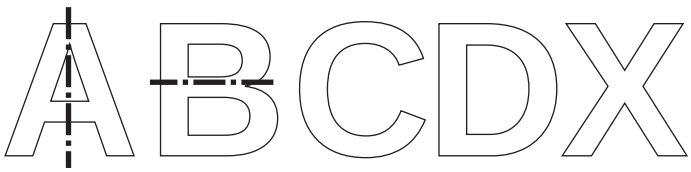
SYMMETRIC ☐ ASYMMETRIC ☐

CANADA

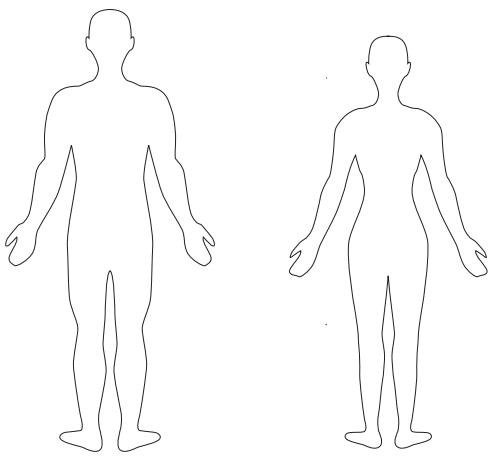
SYMMETRIC ☐ ASYMMETRIC ☐

GREAT BRITAIN

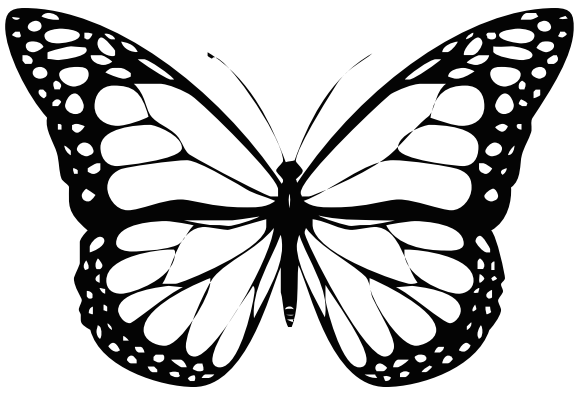
Many capital letters also show symmetries. Knowing this helps tracing them quite a bit. Some letters may contain even two lines of symmetry.
Draw the line of symmetry to the last three letters



So Nature creates its shapes with symmetry. However it is very common that natural symmetry hides slight differences between two symmetric halves. Those small differences show up due to growth issues or other circumstances. When some object is not geometrically and accurately symmetric but still shows a main symmetry we regard to it as an **apparent symmetry**.



Despite human body apears to be completely symmetric. Everyone's body has little imperfections that break the perfect accurate symmetry such as one leg or an arm longer than the other.



Also many animals show a reflexion in their bodies, which is not accurately following the geometric symmetry rules.

In this page you can see a couple examples on how Symmetry inspires artists to make a song or a short movie, bees to find their flowers or even a psychiatrist to prepare his character and psichological tests.

Listen carefully to the song and fill in the gaps:

LITTLE BOOTS - SYMMETRY

You're the night to my _____
And the left to my right
The blood to my veins
And the dark to my light
The stop to my start
And the constant beat of my _____

The sun to my moon
And the stars in my _____
The hot to my cold
And the black to my white
The rain to my thunderclouds
And the truth in my lies

So tell me what you want to see
Coz everything I want to be
Is there in your _____
Shining out right back at me

So love me in perfect symmetry
Be my _____
If you just love me in perfect symmetry
Only you can make me feel complete
In perfect symmetry
Be my everything
If you just love me in perfect symmetry
Only you can make me feel _____

So tell me your dreams and
I'll tell you all my fears
So ask me your _____
I'll tell you what you want to hear

You're the high to my low
And the give to my take
The shadow I cast

And the echo I make
The calm to my storm
And the lesson in my _____

So tell me what you want to see
You're everything I want to be

Just love me in perfect symmetry
Be my everything
If you just love me in perfect symmetry
Only you can make me feel complete
In perfect symmetry
Be my _____
If you just love me in perfect symmetry
Only you can make me feel _____

So tell me your dreams
And I'll tell you my fears
So ask me your questions
What you want to hear

Listen **Symmetry by Little Boots** and see how symmetry also can inspire lyrics for a song.
http://youtu.be/6S9bOriXMEA

HONEY BEES VISION

Did you know the bee's vision is specifically designed to reach out shapes with central or point symmetry?. That is meant for finding better the flowers, which own that quality, in order to get more pollen and produce more honey. And this way flowers which have a better symmetry survive better in time since bees help them reproduce.

THE 20 SYMMETRYCAL IMAGES OF RORSCHACH TEST

Rorschach blot 4.
Source: http://commons.wikimedia.org/

Hermann Rorschach was a Swiss psychiatrist (brain doctor) who developed a test consiting on twenty images that are ambigous abstract symmetric inkblots (ink stains).

His patients would observe the images and tell the doctor or psychologist what they saw, perceive or what it went through their minds.

That way the images meant actually nothing, but the positive or negative information told by the patients could help the therapist to diagnose any problem or issue they had.

SYMMETRY IN VISUAL CONCEPTS. SHORT MOVIE

As we saw symmetry helped a songwriter to compose the lyrics. we can see that it can also help to make up a short movie showing images about opposite concepts.

Watch **this short movie** abou symmetry on Vimeo. It doesn't have much to do with geometry but with the main concep of symmetry.
http://vimeo.com/22564317