GeoGebra Basics

Handbook 3
A Guide for Learning GeoGebra

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Using GeoGebra to construct Polygons and Angles

Hide the axes because we do not need them now: In the **View** menu, click the

⚙

Show Axes button.

Graphics

┴ Show Axes

▦ Show Grid ⌄

C: Snap to Grid ✓

C Clear all Traces

▷ₒ Show all Objects

⚙ Settings

Go to the **Construction** Tools: Select the **Polygon** tool

Polygons
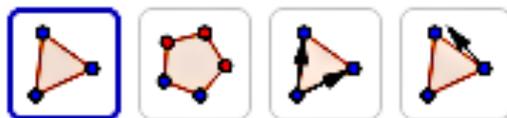
In the Graphic View area: create a triangle by selecting three points which wil be the vertices of the polygon. (Remember to click the first point again in order to close the polygon)

Measure the interior angles: Go to the Construction Tools & Select the Angle tool
Select the three vertices counter clockwise (the measured angle second)

Measure

Calculate the sum of the interior angles

Input: α+β+γ|

Go to the **Input Bar** and type"

Because there is no $\alpha, \beta,$ **and** γ on the keyboard you have to select them from m the dropdown list at the bottom:

Geometry - GeoGebra

$\alpha = \text{Angle}(B, A, C)$
→ 55.5°

$\beta = \text{Angle}(A, C, B)$
→ 44.3°

$\gamma = \text{Angle}(C, B, A)$
→ 80.2°

$\delta = \alpha + \beta + \gamma$
→ 180°

The sum of the angles (which is 180 degrees) will appear in the **Graphics** window. The question that any mathematician will ask is if this is a special case or is it always true?

Go to the **Construction Tools** and select the **Arrow**
Drag the vertices (A, B, and C) of the triangle. GeoGebra will measure the angles immediately and also update the sum of the interior angles.
To save the construction: select the **File** tab and click the **Save** button

# Challenge Problem: Isosceles Triangle Construction

Construct an isosceles triangle whose length of the base and height can be modified by dragging corresponding vertices with the mouse.
You will need to following tools in order to solve this challenge:

✎	Segment		•ᴬ	Point
•ᵒ	Midpoint or Center	New!	▷•	Polygon
⊥	Perpendicular Line		⬐	Move
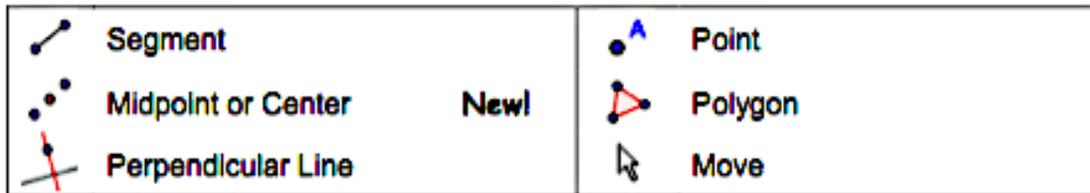
Don't forget to read the Toolbar help if you don't know how to use a tool.

Try out all new tools before you start the construction
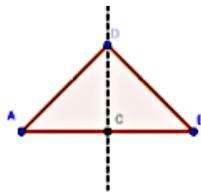
Things to Do

       Summarize the properties of the geometric figure you want to create.
       Try to find out which GeoGebra tools can be used in order to construct the figure using some of these properties (e.g. right angle – tool Perpendicular Line).
       Make sure, you know how to use each tool before you begin the construction. If you don't know how to operate a certain tool, activate it   and read the Toolbar help.
       You might want to save your files before you start a new activity.
       Don't forget about the Undo and Redo buttons in case you make a

mistake.

   Frequently use the Move tool in order to check your construction (e.g. are objects really connected, did you create any unnecessary objects).
   If you have questions, please ask a peer group member before you address the
Dr. Mason.

Construction of a regular polygon

1. Hide the axes: select **View** / Click **Axes** button

2. Select the **Regular Polygon** (Click the small arrow in the bottom right hand corner of the icon to see all the options)
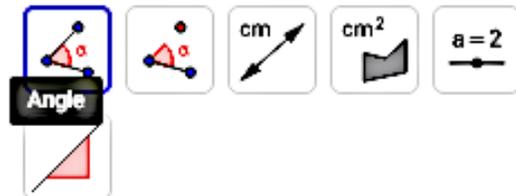
3. Create and equilateral triangle by selecting the two base points. A window will open: **type the number of vertices** (in the case of a triangle 3, square 4, regular pentagon 5) and hit the enter key

4. Measure an interior angle: select the **Angle** tool / Select the three vertices counter clockwise (the measured angle second.

5. Repeat the steps to construct a square, regular polygon, etc.

Dare to Think
Test Your Understanding of Area of Closed Regions

    A. Solve investigations #1 - #5 using GeoGebra.

Investigation #1
       Construct a square with a perimeter that is equal to the circumference of a circle.

Investigation #2
       Construct a square with an area that is equal to the area of a circle.

Investigation #3
       Inscribe a circle in a square. Compare the areas. Compare the perimeter of the square to the circumference of the circle. Present your answers as a ratio.

Investigation #4
       Inscribe a square in a circle. Compare the areas. Compare the perimeter of the square to the circumference of the circle.

Investigation #5
       Construct an equilateral triangle in the interior of a circle. Compare areas and perimeters (circumference of the circle and perimeter of the square.)
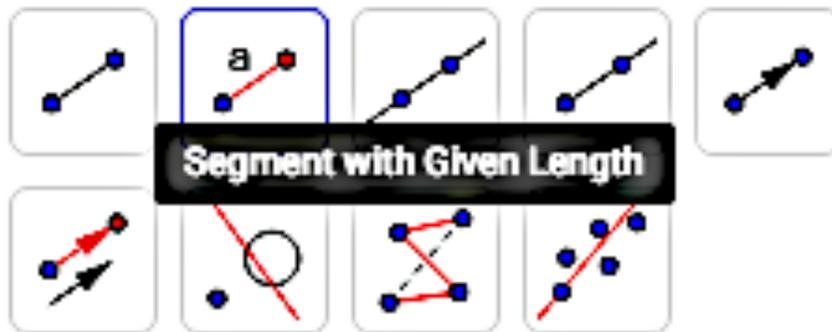
    B. Try solving investigations #1 - #5 algebraically

Using GeoGebra to Find Midpoints of Segments

To construct a median, altitude, perpendicular bisector, and angle bisector of a triangle you need to know the following.

Construct a line segment use the **Segment between Two Points** tool. You will be instructed to select a point and then enter the length of the segment.
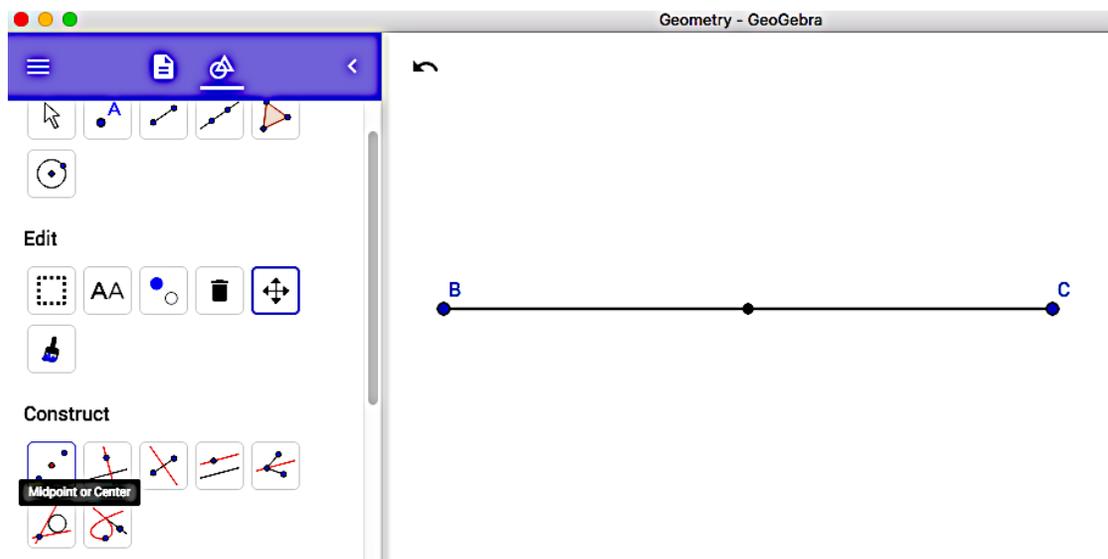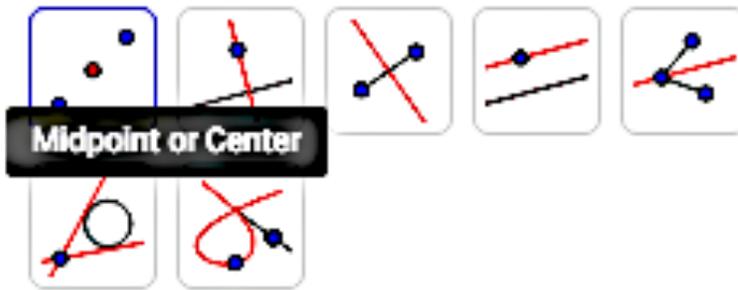
To **Delete** points, segments, lines, equations, and figures, *click the left button on your mouse*

Construct the midpoint of the line segment:
Use the **Midpoint or Center** Tool

Deepening your Understanding Midpoints of Segments – the Mathematics

We can use the properties of rational numbers to find the midpoint of any line segment. Suppose that A and B are two points on a number line with coordinates x_1 and x_2, respectively.

Let the point C be the midpoint of AB and let the coordinate of C be x_m. Now if C is the midpoint of AB then m(AC) = m(CB). Since m(AC) = $|x_m - x_1|$ and m(CB) = $|x_2 - x_m|$ then $|x_m - x_1| = |x_2 - x_m|$. Thus, either

$$x_m - x_1 = x_2 - x_m$$

or

$$(2) \quad x_m - x_1 = -(x_2 - x_m).$$

That is, we may write the following:

$$x_m - x_1 = x_2 - x_m$$

$$x_m = x_1 - x_2$$

$$x_m = x_1 - x/_2$$

or

$$x_m - x_1 = -x_2 + x_m$$

so $x_1 = x_2$

But if A and B are distinct and different points, then (2) is impossible. Therefore, the $\dfrac{x_1 + x_2}{2}$ coordinate of the midpoint.

We can also demonstrate the converse. Suppose C is a point with coordinate x_1 and x_2.

Then C is the $x_m = \dfrac{x_1 + x_2}{2}$ midpoint of AB, because

$$x_m = \frac{x_1 + x_2}{2}$$

$$2x_m = x_1 + x_2$$

$$x_m - x_1 = x_2 - x_m$$

or m(AC)= m(BC).

We can summarize this property as follows: Let A and B be distinct points on a number line having coordinates x1 and x2, respectively. The point C with coordinate am is the midpoint of AB if and only if.

$$x_m = \frac{x_1 + x_2}{2}$$

Do you get the feeling for the generality of this property? There is no need to be concerned about whether x_1 and x_2 are positive or negative, whether $x_1 > x_2$ or even if x_1 and x_2 are rational. Any real numbers will apply. The property is perfectly general and is in no way dependent upon any particular choice of points.

Application of the Midpoint Formula
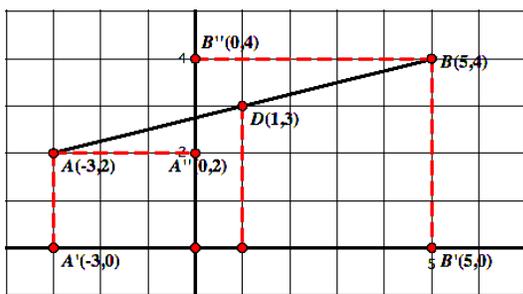
Refer to figure 58 below for this discussion.

Figure 58 – Midpoint 4

Now at (1,0) construct the line perpendicular to the x-axis, meeting AB at D. Thus, the x-coordinate o f D is 1. Doing exactly the same thing on the y-axis, we find A''(0,2) and B''(0,4) = so that the y coordinate of the midpoint is $\frac{2+4}{2} = 3$

Thus, the midpoint of AB, D, will have coordinates (1,3). The general statement appears to be a property and you will be given opportunity to prove it in the problem set.

Property: For any two points $P(x_1, y_1)$ and $Q(x_2, y2)$, the coordinates of the midpoint of PQ are

Equation 1 - Midpoint3

As an example, we can find the coordinates of the midpoint M of the

$$(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2})$$

$$(\frac{1 + 5}{2}, \frac{4 + 2}{2}) = (\frac{6}{2}, \frac{6}{2}) = (3,3).$$

segment AB defined by A(1,4) and B(5,2).