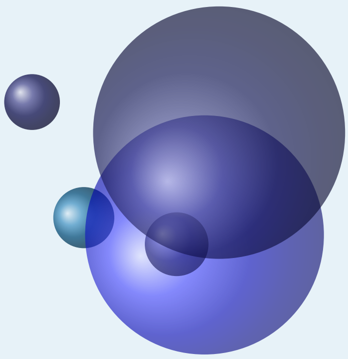
tkz-euclide 5.10c

# AlterMundus

tkz-euclide v5

Euclidean Geometry



Alain Matthes

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http://altermundus.fr

# tkz-euclide

Alain Matthes

AlterMundus

☞

`tkz-euclide` is a set of convenient macros for drawing in a plane (fundamental two-dimensional object) with a Cartesian coordinate system. It handles the most classic situations in Euclidean Geometry. `tkz-euclide` is built on top of PGF and its associated front-end Ti*k*Z and is a (La)TeX-friendly drawing package. The aim is to provide a high-level user interface to build graphics relatively effortlessly. The goal is to guide users through constructing diagrams step by step, mirroring the natural process of manual construction as closely as possible.
Version 5 of `tkz-euclide` includes the option to utilize Lua for performing certain calculations, refer to the `news` and `lua` sections.
Please note: English is not my native language, so there may be some errors.

☞ Firstly, I would like to thank **Till Tantau** for the beautiful LaTeX package, namely Ti*k*Z.

☞ Acknowledgements : I received much valuable advices, remarks, corrections and examples from `Jean-Côme Charpentier`, `Josselin Noirel`, `Manuel Pégourié-Gonnard`, `Franck Pastor`, `David Arnold`, `Ulrike Fischer`, `Stefan Kottwitz`, `Christian Tellechea`, `Nicolas Kisselhoff`, `David Arnold`, `Wolfgang Büchel`,
`John Kitzmiller`, `Dimitri Kapetas`, `Gaétan Marris`, `Mark Wibrow`, `Yves Combe`, `Paul Gaborit`, `Laurent Van Deik` and `Muzimuzhi Z`.

☞ I would also like to thank Eric Weisstein, creator of MathWorld: MathWorld.

☞ You can find some examples on my site: altermundus.fr. under construction!

Please report typos or any other comments to this documentation to: Alain Matthes.

# Contents

# Part I.

# General survey : a brief but comprehensive review

## News and compatibility

### 0.1. With 5.10 version

- Added french documentation
- Added the `mini` option. You can use this option with the `tkz-elements` package. Only the modules required for tracing will be loaded. This option is currently only available if you are using `tkz-elements`.

# 1. Working with lua

## 1.0.1. Option lua

You can now use the `lua` option with **`tkz-euclide`** version 5. You just have to write in your preamble `usepackage[lua]{tkz-euclide}`. Obviously, you'll need to compile with LuaLaTeX. Nothing changes for the syntax.
Without the option you can use **`tkz-euclide`** with the proposed code of version 4.25.
This version is not yet finalized although the documentation you are currently reading has been compiled with this option.
Some information about the method used and the results obtained. Concerning the method, I considered two possibilities. The first one was simply to replace everywhere I could the calculations made by `xfp` or sometimes by `lua`. This is how I went from `fp` to `xfp` and now to `lua`. The second and more ambitious possibility would have been to associate to each point a complex number and to make the calculations on the complexes with `lua`. Unfortunately for that I have to use libraries for which I don't know the license.
Otherwise the results are good. This documentation with `LualaTeX` and `xfp` compiles in 47s while with `lua` it takes only 30s for 236 pages.
Another document of 61 pages is compiled 16s with `pdflaTeX` and `xfp` and 13s with `LualaTeX` and `xfp`.
This documentation compiles with `\usepackage{tkz-base}` and `\usepackage[lua]{tkz-euclide}` but I didn't test all the interactions thoroughly.

## 1.0.2. Option mini

When you use `tkz-elements` solely to determine the points in your figures, it is not necessary to load all the modules of **`tkz-euclide`**. In this case, by using the `mini` option `\usepackage[mini]{tkz-euclide}` , you will only load the modules necessary for the drawings.

# 2. Installation

**`tkz-euclide`** is on the server of the `CTAN`[1]. If you want to test a beta version, just put the following files in a texmf folder that your system can find. You will have to check several points:

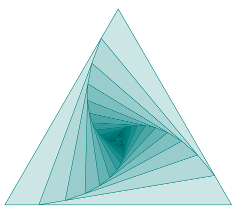
- The **`tkz-euclide`** folder must be located on a path recognized by **`latex`**.
- The **`tkz-euclide`** uses `xfp`.
- You need to have **`PGF`** installed on your computer. **`tkz-euclide`** use several libraries of Ti*k*Z

1 **`tkz-euclide`** is part of `TeXLive` and **`tlmgr`** allows you to install them. This package is also part of `MiKTeX` under `Windows`.

angles,
arrows,
arrows.meta,
calc,
decorations,
decorations.markings,
decorations.pathreplacing,
decorations.shapes,
decorations.text,
decorations.pathmorphing,
intersections,
math,
plotmarks,
positioning,
quotes,
shapes.misc,
through

– This documentation and all examples were obtained with `lualatex` but `pdflatex` or `xelatex` should be suitable.

## 3. Presentation and Overview



```
\begin{tikzpicture}[scale=.25]
\tkzDefPoints{0/0/A,12/0/B,6/12*sind(60)/C}
\foreach \density in {20,30,...,240}{%
  \tkzDrawPolygon[fill=teal!\density](A,B,C)
  \pgfnodealias{X}{A}
  \tkzDefPointWith[linear,K=.15](A,B) \tkzGetPoint{A}
  \tkzDefPointWith[linear,K=.15](B,C) \tkzGetPoint{B}
  \tkzDefPointWith[linear,K=.15](C,X) \tkzGetPoint{C}}
\end{tikzpicture}
```

### 3.1. Why tkz-euclide?

My initial goal was to provide other mathematics teachers and myself with a tool to quickly create Euclidean geometry figures without investing too much effort in learning a new programming language. Of course, **tkz-euclide** is for math teachers who use LaTeX and makes it possible to easily create correct drawings by means of LaTeX.
It appeared that the simplest method was to reproduce the one used to obtain construction by hand. To describe a construction, you must, of course, define the objects but also the actions that you perform. It seemed to me that syntax close to the language of mathematicians and their students would be more easily understandable; moreover, it also seemed to me that this syntax should be close to that of LaTeX. The objects, of course, are points, segments, lines, triangles, polygons and circles. As for actions, I considered five to be sufficient, namely: define, create, draw, mark and label.
The syntax is perhaps too verbose but it is, I believe, easily accessible. As a result, the students like teachers were able to easily access this tool.

### 3.2. TikZ vs tkz-euclide

I love programming with Ti*k*Z, and without Ti*k*Z I would never have had the idea to create **tkz-euclide** but never forget that behind it there is Ti*k*Z and that it is always possible to insert code from Ti*k*Z. **tkz-euclide** doesn't prevent you from using Ti*k*Z. That said, I don't think mixing syntax is a good thing.

There is no need to compare TikZ and **tkz-euclide**. The latter is not addressed to the same audience as TikZ. The first one allows you to do a lot of things, the second one only does geometry drawings. The first one can do everything the second one does, but the second one will more easily do what you want.
The main purpose is to define points to create geometrical figures. **tkz-euclide** allows you to draw the essential objects of Euclidean geometry from these points but it may be insufficient for some actions like coloring surfaces. In this case you will have to use TikZ which is always possible.
Here are some comparisons between **TikZ** and **tkz-euclide** 4. For this I will use the geometry examples from the PGFManual. The two most important Euclidean tools used by early Greeks to construct different geometrical shapes and angles were a compass and a straightedge. My idea is to allow you to follow step by step a construction that would be done by hand (with compass and straightedge) as naturally as possible.

### 3.2.1. Book I, proposition I _Euclid's Elements_

**Book I, proposition I _Euclid's Elements_**

*To construct an equilateral triangle on a given finite straight line.*

Explanation :
The fourth tutorial of the *PgfManual* is about geometric constructions. *T. Tantau* proposes to get the drawing with its beautiful tool TikZ. Here I propose the same construction with *tkz-elements*. The color of the TikZ code is green!50!black and that of *tkz-elements* is red.

```
\usepackage{tikz}
\usetikzlibrary{calc,intersections,through,backgrounds}
```

```
\usepackage{tkz-euclide}
```

How to get the line AB ? To get this line, we use two fixed points.

```
\coordinate [label=left:$A$] (A) at (0,0);
\coordinate [label=right:$B$] (B) at (1.25,0.25);
\draw (A) -- (B);
```

```
\tkzDefPoint(0,0){A}
\tkzDefPoint(1.25,0.25){B}
\tkzDrawSegment(A,B)
\tkzLabelPoint[left](A){$A$}
\tkzLabelPoint[right](B){$B$}
```

We want to draw a circle around the points A and B whose radius is given by the length of the line AB.

```
\draw let \p1 = ($ (B) - (A) $),
\n2 = {veclen(\x1,\y1)} in
          (A) circle (\n2)
          (B) circle (\n2);
```

```
\tkzDrawCircles(A,B B,A)
```

The intersection of the circles $\mathcal{D}$ and $\mathcal{E}$

```
draw [name path=A--B] (A) -- (B);
node (D) [name path=D,draw,circle through=(B),label=left:$D$] at (A) {};
node (E) [name path=E,draw,circle through=(A),label=right:$E$] at (B) {};
path [name intersections={of=D and E, by={[label=above:$C$]C,[label=below:$C'$]C'}}];
draw [name path=C--C',red] (C) -- (C');
path [name intersections={of=A--B and C--C',by=F}];
node [fill=red,inner sep=1pt,label=-45:$F$] at (F) {};
```

```
\tkzInterCC(A,B)(B,A) \tkzGetPoints{C}{X}
```

How to draw points :

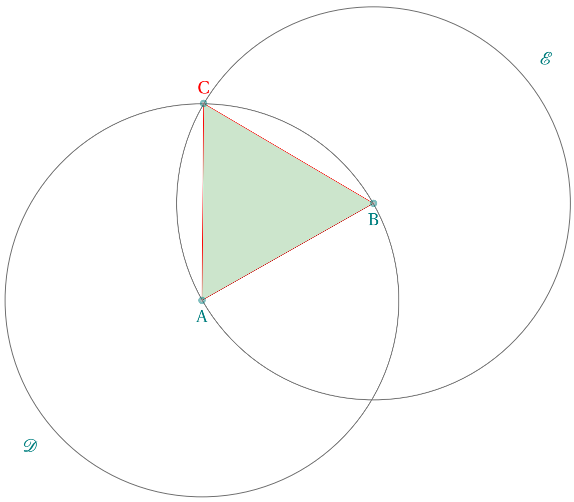
```
\foreach \point in {A,B,C}
\fill [black,opacity=.5] (\point) circle (2pt);
```

```
\tkzDrawPoints[fill=gray,opacity=.5](A,B,C)
```

### 3.2.2. Complete code with tkz-euclide

We need to define colors

\colorlet{input}{red!80!black}
\colorlet{output}{red!70!black}
\colorlet{triangle}{green!50!black!40}




```
\colorlet{input}{red!80!black}
\colorlet{output}{red!70!black}
\colorlet{triangle}{green!50!black!40}
\begin{tikzpicture}[scale=1.25,thick,help lines/.style={thin,draw=black!50}]
\tkzDefPoint(0,0){A}
\tkzDefPoint(1.25+rand(),0.25+rand()){B}
\tkzInterCC(A,B)(B,A) \tkzGetPoints{C}{X}

\tkzFillPolygon[triangle,opacity=.5](A,B,C)
\tkzDrawSegment[input](A,B)
\tkzDrawSegments[red](A,C B,C)
\tkzDrawCircles[help lines](A,B B,A)
\tkzDrawPoints[fill=gray,opacity=.5](A,B,C)

\tkzLabelPoints(A,B)
\tkzLabelCircle[below=12pt](A,B)(180){$\mathcal{D}$}
\tkzLabelCircle[above=12pt](B,A)(180){$\mathcal{E}$}
\tkzLabelPoint[above,red](C){$C$}

\end{tikzpicture}
```

### 3.2.3. Book I, Proposition II _Euclid's Elements_

**Book I, Proposition II _Euclid's Elements_**

*To place a straight line equal to a given straight line with one end at a given point.*

Explanation
In the first part, we need to find the midpoint of the straight line AB. With Ti*k*Z we can use the calc library

```
\coordinate [label=left:$A$] (A) at (0,0);
\coordinate [label=right:$B$] (B) at (1.25,0.25);
\draw (A) -- (B);
\node [fill=red,inner sep=1pt,label=below:$X$] (X) at ($ (A)!.5!(B) $) {};
```

With `tkz-euclide` we have a macro `\tkzDefMidPoint`, we get the point X with `\tkzGetPoint` but we don't need this point to get the next step.

```
\tkzDefPoints{0/0/A,0.75/0.25/B,1/1.5/C}
\tkzDefMidPoint(A,B) \tkzGetPoint{X}
```

Then we need to construct a triangle equilateral. It's easy with `tkz-euclide` . With TikZ you need some effort because you need to use the midpoint X to get the point D with trigonometry calculation.

```
\node [fill=red,inner sep=1pt,label=below:$X$] (X) at ($ (A)!.5!(B) $) {};
\node [fill=red,inner sep=1pt,label=above:$D$] (D) at
($ (X) ! {sin(60)*2} ! 90:(B) $) {};
\draw (A) -- (D) -- (B);
```

```
\tkzDefTriangle[equilateral](A,B) \tkzGetPoint{D}
```

We can draw the triangle at the end of the picture with

```
\tkzDrawPolygon{A,B,C}
```

We know how to draw the circle $\mathcal{H}$ around B through C and how to place the points E and F

```
\node (H) [label=135:$H$,draw,circle through=(C)] at (B) {};
\draw (D) -- ($ (D) ! 3.5 ! (B) $) coordinate [label=below:$F$] (F);
\draw (D) -- ($ (D) ! 2.5 ! (A) $) coordinate [label=below:$E$] (E);
```

```
\tkzDrawCircle(B,C)
\tkzDrawLines[add=0 and 2](D,A D,B)
```

We can place the points E and F at the end of the picture. We don't need them now.
Intersecting a Line and a Circle : here we search the intersection of the circle around B through C and the line DB. The infinite straight line DB intercepts the circle but with Ti*k*Z we need to extend the lines DB and that can be done using partway calculations. We get the point F and BF or DF intercepts the circle

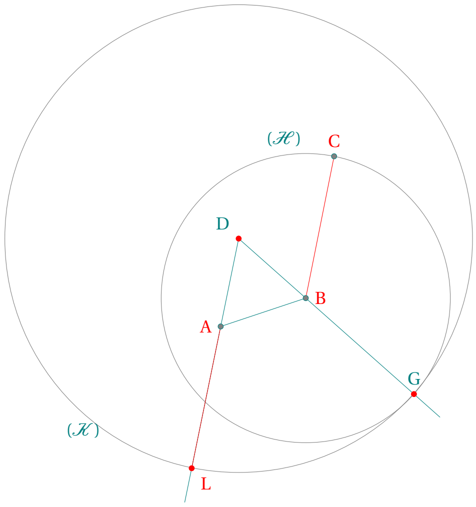
```
 \node (H) [label=135:$H$,draw,circle through=(C)] at (B) {};
\path let \p1 = ($ (B) - (C) $) in
  coordinate [label=left:$G$] (G) at ($ (B) ! veclen(\x1,\y1) ! (F) $);
\fill[red,opacity=.5] (G) circle (2pt);
```

Like the intersection of two circles, it's easy to find the intersection of a line and a circle with `tkz-euclide`. We don't need F

```
 \tkzInterLC(B,D)(B,C)\tkzGetFirstPoint{G}
```

There are no more difficulties. Here the final code with some simplications. We draw the circle $\mathcal{K}$ with center D and passing through G. It intersects the line AD at point L. AL = BC.
`\tkzDrawCircle(D,G)`

\tkzInterLC(D,A)(D,G)\tkzGetSecondPoint{L}




```
\begin{tikzpicture}[scale=1.5]
\tkzDefPoint(0,0){A}
\tkzDefPoint(0.75,0.25){B}
\tkzDefPoint(1,1.5){C}
\tkzDefTriangle[equilateral](A,B)\tkzGetPoint{D}
\tkzInterLC[near](D,B)(B,C)       \tkzGetSecondPoint{G}
\tkzInterLC[near](A,D)(D,G)       \tkzGetFirstPoint{L}
\tkzDrawCircles(B,C D,G)
\tkzDrawLines[add=0 and 2](D,A D,B)
\tkzDrawSegment(A,B)
\tkzDrawSegments[red](A,L B,C)
\tkzDrawPoints[red](D,L,G)
\tkzDrawPoints[fill=gray](A,B,C)
\tkzLabelPoints[left,red](A)
\tkzLabelPoints[below right,red](L)
\tkzLabelCircle[above](B,C)(20){$\mathcal{(H)}$}
\tkzLabelPoints[above left](D)
\tkzLabelPoints[above](G)
\tkzLabelPoints[above,red](C)
\tkzLabelPoints[right,red](B)
\tkzLabelCircle[below](D,G)(-90){$\mathcal{(K)}$}
\end{tikzpicture}
```

### 3.3. tkz-euclide 4 vs tkz-euclide 3

Now I am no longer a Mathematics teacher, and I only spend a few hours studying geometry. I wanted to avoid multiple complications by trying to make `tkz-euclide` independent of `tkz-base`. Thus was born `tkz-euclide` 4. The latter is a simplified version of its predecessor. The macros of `tkz-euclide 3` have been retained. The unit is now `cm`. If you need some macros from `tkz-base`, you may need to use the `\tkzInit`.

### 3.4. tkz-euclide 5 vs tkz-euclide 4

Nothing changes for the user. Compilation must be carried out using the LuaLaTeX engine, and the results are more precise and obtained more quickly. Simply load `tkz-euclide` like this `\usepackage[lua]{tkz-euclide}`.

### 3.5. How to use the tkz-euclide package ?

#### 3.5.1. Let's look at a classic example

In order to show the right way, we will see how to build an equilateral triangle. Several possibilities are open to us, we are going to follow the steps of Euclid.

– First of all, you have to use a document class. The best choice to test your code is to create a single figure with the class `standalone`.

```
\documentclass{standalone}
```

– Then load the `tkz-euclide` package:

```
\usepackage{tkz-euclide} or \usepackage[lua]{tkz-euclide}
```

You don't need to load Ti*k*Z because the `tkz-euclide` package works on top of TikZ and loads it.

– Start the document and open a TikZ picture environment:

```
\begin{document}
\begin{tikzpicture}
```

– Now we define two fixed points:

```
\tkzDefPoint(0,0){A}
\tkzDefPoint(5,2){B}
```

– Two points define two circles, let's use these circles:

circle with center A through B and circle with center B through A. These two circles have two points in common.

```
\tkzInterCC(A,B)(B,A)
```

We can get the points of intersection with

```
\tkzGetPoints{C}{D}
```

– All the necessary points are obtained, we can move on to the final steps including the plots.

```
\tkzDrawCircles[gray,dashed](A,B B,A)
\tkzDrawPolygon(A,B,C)% The triangle
```

– Draw all points A, B, C and D:

```
\tkzDrawPoints(A,...,D)
```

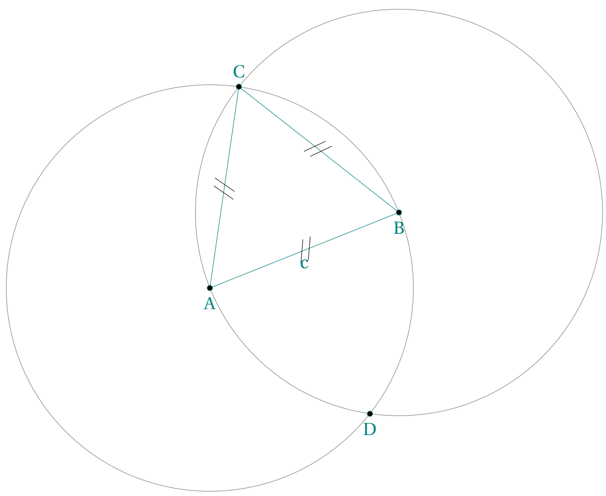
– The final step, we print labels to the points and use options for positioning:

```
\tkzLabelSegments[swap](A,B){$c$}
\tkzLabelPoints(A,B,D)
\tkzLabelPoints[above](C)
```

– We finally close both environments

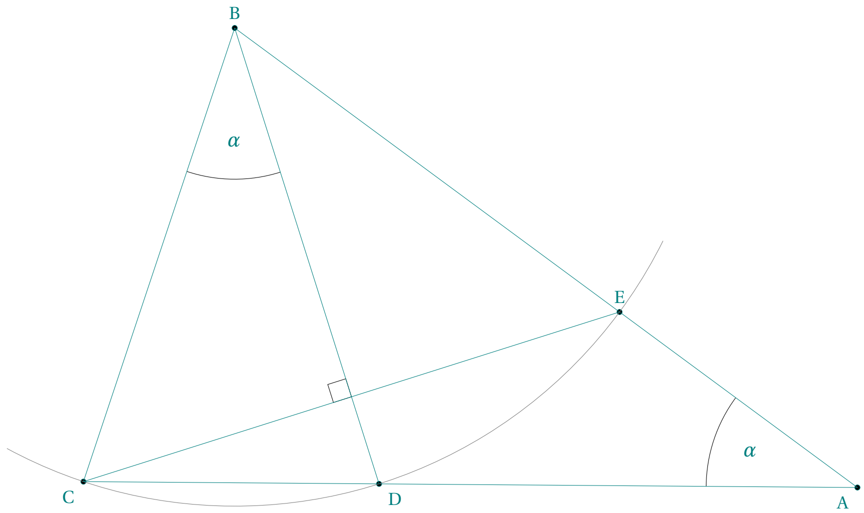
```
\end{tikzpicture}
\end{document}
```

– The complete code




```
\begin{tikzpicture}[scale=.5]
  % fixed points
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(5,2){B}
  % calculus
  \tkzInterCC(A,B)(B,A)
  \tkzGetPoints{C}{D}
  % drawings
  \tkzDrawCircles(A,B B,A)
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPoints(A,...,D)
  % marking
  \tkzMarkSegments[mark=s||](A,B B,C C,A)
  % labelling
  \tkzLabelSegments[swap](A,B){$c$}
  \tkzLabelPoints(A,B,D)
  \tkzLabelPoints[above](C)
\end{tikzpicture}
```

### 3.5.2. Part I: golden triangle




Let's analyze the figure

1. CBD and DBE are isosceles triangles;
2. BC = BE and (BD) is a bisector of the angle CBE;
3. From this we deduce that the CBD and DBE angles are equal and have the same measure $\alpha$

$$\widehat{\mathrm{BAC}}+\widehat{\mathrm{ABC}}+\widehat{\mathrm{BCA}}=180^\circ \text{ in the triangle BAC}$$

$$3\alpha+\widehat{\mathrm{BCA}}=180^\circ \text{ in the triangle CBD}$$

   then

$$\alpha+2\widehat{\mathrm{BCA}}=180^\circ$$

   or

$$\widehat{\mathrm{BCA}}=90^\circ-\alpha/2$$

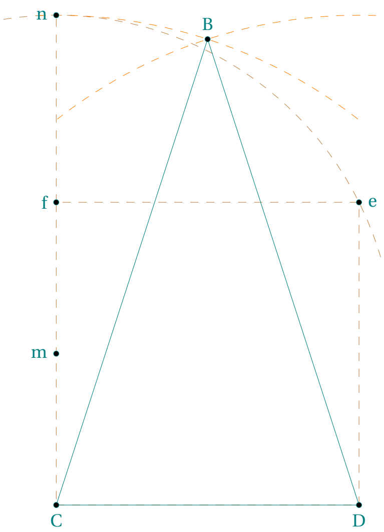
4. Finally

$$\widehat{\mathrm{CBD}}=\alpha=36^\circ$$

   the triangle CBD is a `golden` triangle.

How construct a golden triangle or an angle of 36°?

1. We place the fixed points C and D. `\tkzDefPoint(0,0){C}` and `\tkzDefPoint(4,0){D}`;
2. We construct a square CDef and we construct the midpoint m of [Cf];
   We can do all of this with a compass and a rule;
3. Then we trace an arc with center m through e. This arc cross the line (Cf) at n;
4. Now the two arcs with center C and D and radius Cn define the point B.




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){C}
  \tkzDefPoint(4,0){D}
  \tkzDefSquare(C,D)
  \tkzGetPoints{e}{f}
  \tkzDefMidPoint(C,f)
  \tkzGetPoint{m}
  \tkzInterLC(C,f)(m,e)
  \tkzGetSecondPoint{n}
  \tkzInterCC[with nodes](C,C,n)(D,C,n)
  \tkzGetFirstPoint{B}
  \tkzDrawSegment[brown,dashed](f,n)
  \pgfinterruptboundingbox% from tikz
  \tkzDrawPolygon[brown,dashed](C,D,e,f)
  \tkzDrawArc[brown,dashed](m,e)(n)
  \tkzCompass[brown,dashed,delta=20](C,B)
  \tkzCompass[brown,dashed,delta=20](D,B)
  \endpgfinterruptboundingbox
  \tkzDrawPolygon(B,...,D)
  \tkzDrawPoints(B,C,D,e,f,m,n)
  \tkzLabelPoints[above](B)
  \tkzLabelPoints[left](f,m,n)
  \tkzLabelPoints(C,D)
  \tkzLabelPoints[right](e)
\end{tikzpicture}
```

After building the golden triangle BCD, we build the point A by noticing that BD = DA. Then we get the point E and finally the point F. This is done with already intersections of defined objects (line and circle).

### 3.5.3. Part II: two others methods with golden and euclid triangle

**tkz-euclide** knows how to define a `golden` or `euclide` triangle. We can define BCD and BCA like gold triangles.

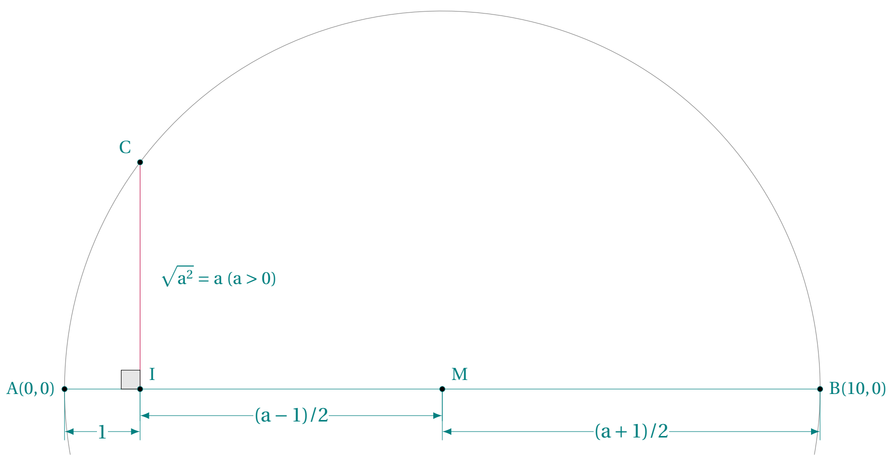
```
\begin{tikzpicture}
  \tkzDefPoint(0,0){C}
  \tkzDefPoint(4,0){D}
  \tkzDefTriangle[golden](C,D)
  \tkzGetPoint{B}
  \tkzDefTriangle[golden](B,C)
  \tkzGetPoint{A}
  \tkzInterLC(B,A)(B,D) \tkzGetSecondPoint{E}
  \tkzInterLL(B,D)(C,E) \tkzGetPoint{F}
  \tkzDrawPoints(C,D,B)
  \tkzDrawPolygon(B,...,D)
  \tkzDrawPolygon(B,C,D)
  \tkzDrawSegments(D,A A,B C,E)
  \tkzDrawArc[delta=10](B,C)(E)
  \tkzDrawPoints(A,...,F)
  \tkzMarkRightAngle(B,F,C)
  \tkzMarkAngles(C,B,D E,A,D)
  \tkzLabelAngles[pos=1.5](C,B,D E,A,D){$\alpha$}
  \tkzLabelPoints[below](A,C,D,E)
  \tkzLabelPoints[above right](B,F)
\end{tikzpicture}
```

Here is a final method that uses rotations:

```
\begin{tikzpicture}
\tkzDefPoint(0,0){C} % possible
% \tkzDefPoint[label=below:$C$](0,0){C}
% but don't do this
\tkzDefPoint(2,6){B}
% We get D and E with a rotation
\tkzDefPointBy[rotation= center B angle 36](C) \tkzGetPoint{D}
\tkzDefPointBy[rotation= center B angle 72](C) \tkzGetPoint{E}
% To get A we use an intersection of lines
\tkzInterLL(B,E)(C,D) \tkzGetPoint{A}
\tkzInterLL(C,E)(B,D) \tkzGetPoint{H}
% drawing
\tkzDrawArc[delta=10](B,C)(E)
\tkzDrawPolygon(C,B,D)
\tkzDrawSegments(D,A B,A C,E)
% angles
\tkzMarkAngles(C,B,D E,A,D) %this is to draw the arcs
\tkzLabelAngles[pos=1.5](C,B,D E,A,D){$\alpha$}
\tkzMarkRightAngle(B,H,C)
\tkzDrawPoints(A,...,E)
% Label only now
\tkzLabelPoints[below left](C,A)
\tkzLabelPoints[below right](D)
\tkzLabelPoints[above](B,E)
\end{tikzpicture}
```

### 3.5.4. Complete but minimal example

A unit of length being chosen, the example shows how to obtain a segment of length $\sqrt{a}$ from a segment of length a, using a ruler and a compass.
IB = a, AI = 1



```
\begin{tikzpicture}[scale=1,ra/.style={fill=gray!20}]
   % fixed points
   \tkzDefPoint(0,0){A}
   \tkzDefPoint(1,0){I}
   % calculation
   \tkzDefPointBy[homothety=center A ratio  10 ](I) \tkzGetPoint{B}
   \tkzDefMidPoint(A,B)              \tkzGetPoint{M}
   \tkzDefPointWith[orthogonal](I,M) \tkzGetPoint{H}
   \tkzInterLC(I,H)(M,B)             \tkzGetFirstPoint{C}
   \tkzDrawSegment[style=purple](I,C)
   \tkzDrawArc(M,B)(A)
   \tkzDrawSegment[dim={$1$,-16pt,}](A,I)
   \tkzDrawSegment[dim={$(a-1)/2$,-10pt,}](I,M)
   \tkzDrawSegment[dim={$(a+1)/2$,-16pt,}](M,B)
   \tkzMarkRightAngle[ra](A,I,C)
   \tkzDrawPoints(I,A,B,C,M)
   \tkzLabelPoint[left](A){$A(0,0)$}
   \tkzLabelPoints[above right](I,M)
   \tkzLabelPoints[above left](C)
   \tkzLabelPoint[right](B){$B(10,0)$}
   \tkzLabelSegment[right=4pt](I,C){$\sqrt{a^2}=a \ (a>0)$}
\end{tikzpicture}
```

*Comments*

– The Preamble

  Let us first look at the preamble. If you need it, you have to load `xcolor` before `tkz-euclide`, that is, before Ti*k*Z. Ti*k*Z may cause problems with the active characters, but... provides a library in its latest version that's supposed to solve these problems `babel`.

```
\documentclass{standalone} % or another class
   % \usepackage{xcolor} % before tikz or tkz-euclide if necessary
\usepackage{tkz-euclide} % no need to load TikZ
   % \usetkzobj{all}  is no longer necessary
   % \usetikzlibrary{babel}  if there are problems with the active characters
```

  The following code consists of several parts:

– Definition of fixed points: the first part includes the definitions of the points necessary for the construction, these are the fixed points. The macros `\tkzInit` and `\tkzClip` in most cases are not necessary.

```
\tkzDefPoint(0,0){A}
\tkzDefPoint(1,0){I}
```

– The second part is dedicated to the creation of new points from the fixed points; a B point is placed at 10 cm from A. The middle of [AB] is defined by M and then the orthogonal line to the (AB) line is searched for at the I point. Then we look for the intersection of this line with the semi-circle of center M passing through A.

```
\tkzDefPointBy[homothety=center A ratio  10 ](I)
   \tkzGetPoint{B}
\tkzDefMidPoint(A,B)
   \tkzGetPoint{M}
\tkzDefPointWith[orthogonal](I,M)
   \tkzGetPoint{H}
\tkzInterLC(I,H)(M,B)
\tkzGetSecondPoint{C}
```

– The third one includes the different drawings;

```
\tkzDrawSegment[style=purple](I,H)
\tkzDrawPoints(O,I,A,B,M)
\tkzDrawArc(M,A)(O)
\tkzDrawSegment[dim={$1$,-16pt,}](A,I)
\tkzDrawSegment[dim={$a/2$,-10pt,}](I,M)
\tkzDrawSegment[dim={$a/2$,-16pt,}](M,B)
```

– Marking: the fourth is devoted to marking;

```
\tkzMarkRightAngle[ra](A,I,C)
```

– Labelling: the latter only deals with the placement of labels.

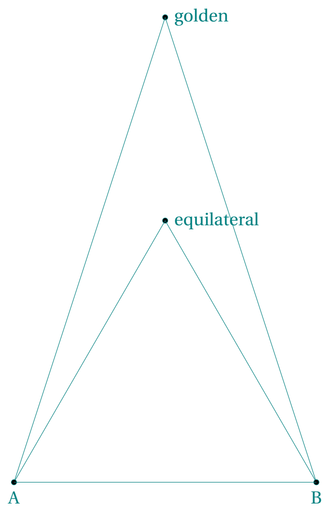
```
\tkzLabelPoint[left](A){$A(0,0)$}
\tkzLabelPoint[right](B){$B(10,0)$}
\tkzLabelSegment[right=4pt](I,C){$\sqrt{a^2}=a \ (a>0)$}
```

## 4. The Elements of tkz code

To work with my package, you need to have notions of LaTeX as well as TikZ.
In this paragraph, we start looking at the `rules` and `symbols` used to create a figure with **`tkz-euclide`**.

### 4.1. Objects and language

The primitive objects are points. You can refer to a point at any time using the name given when defining it. (it is possible to assign a different name later on).
To get new points you will use macros. **`tkz-euclide`** macros have a name beginning with tkz. There are four main categories starting with: `\tkzDef...` `\tkzDraw...` `\tkzMark...` and `\tkzLabel...`. The used points are passed as parameters between parentheses while the created points are between braces.
The code of the figures is placed in an environment `tikzpicture`
Contrary to TikZ, you should not end a macro with ";". We thus lose the important notion which is the `path`. However, it is possible to place some code between the macros **`tkz-euclide`**.
Among the first category, `\tkzDefPoint` allows you to define fixed points. It will be studied in detail later. Here we will see in detail the macro `\tkzDefTriangle`.
This macro makes it possible to associate to a pair of points a third point in order to define a certain triangle `\tkzDefTriangle(A,B)`. The obtained point is referenced `tkzPointResult` and it is possible to choose another reference with `\tkzGetPoint{C}` for example.
`\tkzDefTriangle[euclid](A,B) \tkzGetPoint{C}`
Parentheses are used to pass arguments. In `(A,B)` A and B are the points with which a third will be defined. However, in `{C}` we use braces to retrieve the new point.
In order to choose a certain type of triangle among the following choices: `equilateral`, `isosceles right`, `half`, `pythagoras`, `school`, `golden or sublime`, `euclid`, `gold`, `cheops`... and `two angles` you just have to choose between hooks, for example:




```
\begin{tikzpicture}[scale=.5]
\tkzDefPoints{0/0/A,8/0/B}
\foreach \tr in {golden, equilateral}
{\tkzDefTriangle[\tr](A,B) \tkzGetPoint{C}
\tkzDrawPoint(C)
\tkzLabelPoint[right](C){\tr}
\tkzDrawSegments(A,C C,B)}
\tkzDrawPoints(A,B)
\tkzDrawSegments(A,B)
\tkzLabelPoints(A,B)
\end{tikzpicture}
```

### 4.2. Notations and conventions

I deliberately chose to use the geometric French and personal conventions to describe the geometric objects represented. The objects defined and represented by **tkz-euclide** are points, lines and circles located in a plane. They are the primary objects of Euclidean geometry from which we will construct figures.
According to Euclid, these figures will only illustrate pure ideas produced by our brain. Thus a point has no dimension and therefore no real existence. In the same way the line has no width and therefore no existence in the real world. The objects that we are going to consider are only representations of ideal mathematical objects. **tkz-euclide** will follow the steps of the ancient Greeks to obtain geometrical constructions using the ruler and the compass.
Here are the notations that will be used:

– The points are represented geometrically either by a small disc or by the intersection of two lines (two straight lines, a straight line and a circle or two circles). In this case, the point is represented by a cross.


```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/2/B}
  \tkzDrawPoints(A,B)
  \tkzLabelPoints(A,B)
\end{tikzpicture}
```

or else


```
\begin{tikzpicture}
  \tkzSetUpPoint[shape=cross, color=red]
  \tkzDefPoints{0/0/A,4/2/B}
  \tkzDrawPoints(A,B)
  \tkzLabelPoints(A,B)
  \end{tikzpicture}
```

The existence of a point being established, we can give it a label which will be a capital letter (with some exceptions) of the Latin alphabet such as A, B or C. For example:

- O is a center for a circle, a rotation, etc.;
- M defined a midpoint;
- H defined the foot of an altitude;
- P′ is the image of P by a transformation ;

It is important to note that the reference name of a point in the code may be different from the label to designate it in the text. So we can define a point A and give it as label P. In particular the style will be different, point A will be labeled A.




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDrawPoints(A)
  \tkzLabelPoint(A){$P$}
\end{tikzpicture}
```

Exceptions: some points such as the middle of the sides of a triangle share a characteristic, so it is normal that their names also share a common character. We will designate these points by $M_a$, $M_b$ and $M_c$ or $M_A$, $M_B$ and $M_C$.

In the code, these points will be referred to as: M_A, M_B and M_C.

Another exception relates to intermediate construction points which will not be labelled. They will often be designated by a lowercase letter in the code.

- The line segments are designated by two points representing their ends in square brackets: [AB].
- The straight lines are in Euclidean geometry defined by two points so A and B define the straight line (AB). We can also designate this stright line using the Greek alphabet and name it $(\delta)$ or $(\Delta)$. It is also possible to designate the straight line with lowercase letters such as d and $d'$.
- The semi-straight line is designated as follows [AB).
- Relation between the straight lines. Two perpendicular (AB) and (CD) lines will be written $(AB) \perp (CD)$ and if they are parallel we will write $(AB) \mathbin{/\!/} (CD)$.
- The lengths of the sides of triangle ABC are AB, AC and BC. The numbers are also designated by a lowercase letter so we will write: $AB = c$, $AC = b$ and $BC = a$. The letter a is also used to represent an angle, and r is frequently used to represent a radius, d a diameter, l a length, d a distance.
- Polygons are designated afterwards by their vertices so ABC is a triangle, EFGH a quadrilateral.
- Angles are generally measured in degrees (ex 60°) and in an equilateral ABC triangle we will write $\widehat{ABC} = \widehat{B} = 60^\circ$.
- The arcs are designated by their extremities. For example if A and B are two points of the same circle then $\widearc{AB}$.
- Circles are noted either $\mathscr{C}$ if there is no possible confusion or $\mathscr{C}(O\,;A)$ for a circle with center O and passing through the point A or $\mathscr{C}(O\,;1)$ for a circle with center O and radius 1 cm.
- Name of the particular lines of a triangle: I used the terms bisector, bisector out, mediator (sometimes called perpendicular bisectors), altitude, median and symmedian.
- $(x_1,y_1)$ coordinates of the point $A_1$, $(x_A,y_A)$ coordinates of the point A.

## 4.3. Set, Calculate, Draw, Mark, Label

The title could have been: `Separation of Calculus and Drawings`
When a document is prepared using the LaTeX system, the source code of the document can be divided into two parts: the document body and the preamble. Under this methodology, publications can be structured, styled and typeset with minimal effort. I propose a similar methodology for creating figures with **tkz-euclide**.
The first part defines the fixed points, the second part allows the creation of new points. `Set and Calculate` are the two main parts. All that is left to do is to draw (or fill), mark and label. It is possible that **tkz-euclide** is insufficient for some of these latter actions but you can use Ti*k*Z

One last remark that I think is important, it is best to avoid introducing coordinates within a code as much as possible. I think that the coordinates should appear at the beginning of the code with the fixed points. Then the use of references is recommended. Most macros have the option **nodes** or **with nodes**.
I also think it's best to define the styles of the different objects from the beginning.

## 5. About this documentation and the examples

It is obtained by compiling with `lualatex`. I use a class **doc.cls** based on **scrartcl**.
Below the list of styles used in the documentation. To understand how to use the styles see the section 38

```
\tkzSetUpColors[background=white,text=black]
\tkzSetUpCompass[color=orange, line width=.2pt,delta=10]
\tkzSetUpArc[color=gray,line width=.2pt]
\tkzSetUpPoint[size=2,color=teal]
\tkzSetUpLine[line width=.2pt,color=teal]
\tkzSetUpStyle[color=orange,line width=.2pt]{new}
\tikzset{every picture/.style={line width=.2pt}}
\tikzset{label angle style/.append style={color=teal,font=\footnotesize}}
\tikzset{label style/.append style={below,color=teal,font=\scriptsize}}
```

Some examples use predefined styles like

```
\tikzset{new/.style={color=orange,line width=.2pt}}
```

# Part II.

# Setting

## 6. First step: fixed points

The first step in a geometric construction is to define the fixed points from which the figure will be constructed. The general idea is to avoid manipulating coordinates and to prefer to use the references of the points fixed in the first step or obtained using the tools provided by the package. Even if it's possible, I think it's a bad idea to work directly with coordinates. Preferable is to use named points.
**tkz-euclide** uses macros and vocabulary specific to geometric construction. It is of course possible to use the tools of Ti*k*Z but it seems more logical to me not to mix the different syntaxes.
A point in **tkz-euclide** is a particular `node` for Ti*k*Z. In the next section we will see how to define points using coordinates. The style of the points (color and shape) will not be discussed. You will find some indications in some examples; for more information you can read the following section 38.

## 7. Definition of a point : \tkzDefPoint or \tkzDefPoints

Points can be specified in any of the following ways:

- Cartesian coordinates;
- Polar coordinates;
- Named points;
- Relative points.

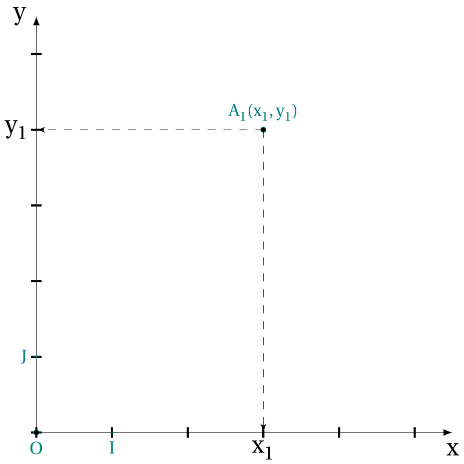
A point is defined if it has a name linked to a unique pair of decimal numbers. Let $(x, y)$ or $(a\colon d)$ i.e. (x abscissa, y ordinate) or (a angle: d distance). This is possible because the plan has been provided with an orthonormed Cartesian coordinate system. The working axes are (ortho)normed with unity equal to 1 cm.
The Cartesian coordinate $(a, b)$ refers to the point a centimeters in the x-direction and b centimeters in the y-direction.
A point in polar coordinates requires an angle $\alpha$, in degrees, and a distance d from the origin with a dimensional unit by default it's the `cm`.
The `\tkzDefPoint` macro is used to define a point by assigning coordinates to it. This macro is based on `\coordinate`, a macro of Ti*k*Z. It can use Ti*k*Z-specific options such as **shift**. If calculations are required then the `xfp` package is chosen. We can use Cartesian or polar coordinates.

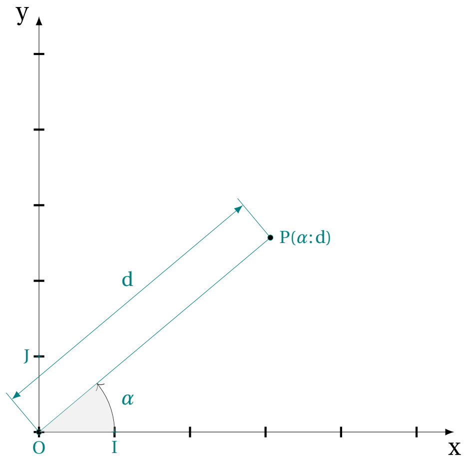
Cartesian coordinates

```
\begin{tikzpicture}[scale=1]
  \tkzInit[xmax=5,ymax=5]
  % necessary to limit
  % the size of the axes
  \tkzDrawX[>=latex]
  \tkzDrawY[>=latex]
  \tkzDefPoints{0/0/O,1/0/I,0/1/J}
  \tkzDefPoint(3,4){A}
  \tkzDrawPoints(O,A)
  \tkzLabelPoint[above](A){$A_1(x_1,y_1)$}
  \tkzShowPointCoord[xlabel=$x_1$,
                     ylabel=$y_1$](A)
  \tkzLabelPoints(O,I)
  \tkzLabelPoints[left](J)
  \tkzDrawPoints[shape=cross](I,J)
\end{tikzpicture}
```

Polar coordinates

```
\begin{tikzpicture}[scale=1]
  \tkzInit[xmax=5,ymax=5]
  \tkzDrawX[>=latex]
  \tkzDrawY[>=latex]
  \tkzDefPoints{0/0/O,1/0/I,0/1/J}
  \tkzDefPoint(40:4){P}
  \tkzDrawSegment[dim={$d$,
                 16pt,above=6pt}](O,P)
  \tkzDrawPoints(O,P)
  \tkzMarkAngle[mark=none,->](I,O,P)
  \tkzFillAngle[opacity=.5](I,O,P)
  \tkzLabelAngle[pos=1.25](I,O,P){%
                               $\alpha$}
  \tkzLabelPoint[right](P){$P(\alpha:d)$}
  \tkzDrawPoints[shape=cross](I,J)
  \tkzLabelPoints(O,I)
  \tkzLabelPoints[left](J)
\end{tikzpicture}
```




### 7.1. Defining a named point \tkzDefPoint

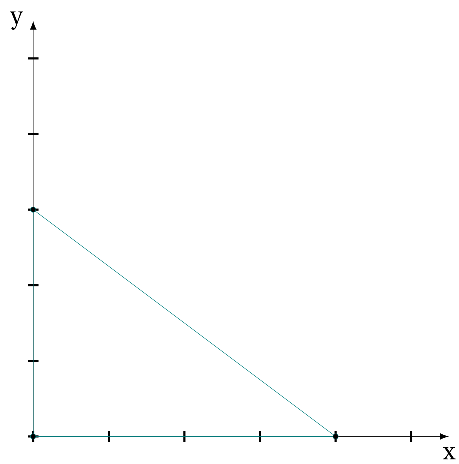
**\tkzDefPoint[⟨local options⟩](⟨x,y⟩){⟨ref⟩} or (⟨α:d⟩){⟨ref⟩}**

| arguments | default | definition |
|---|---|---|
| (x,y) | no default | x and y are two dimensions, by default in cm. |
| (α:d) | no default | α is an angle in degrees, d is a dimension |
| {ref} | no default | Reference assigned to the point: A, T_a ,P1 or $P_1$ |

*The obligatory arguments of this macro are two dimensions expressed with decimals, in the first case they are two measures of length, in the second case they are a measure of length and the measure of an angle in degrees. Do not confuse the reference with the name of a point. The reference is used by calculations, but frequently, the name is identical to the reference.*

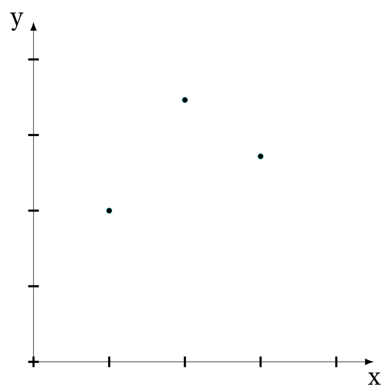
| options | default | definition |
|---|---|---|
| label | no default | allows you to place a label at a predefined distance |
| shift | no default | adds (x,y) or (α:d) to all coordinates |

#### 7.1.1. Cartesian coordinates



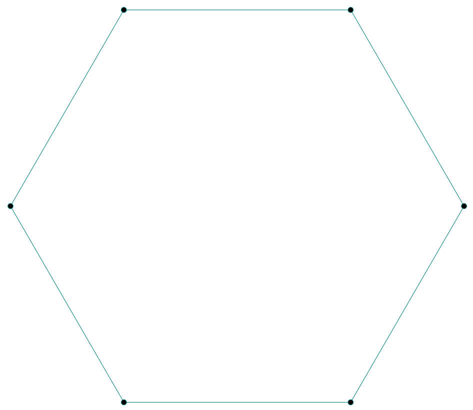

```
\begin{tikzpicture}
\tkzInit[xmax=5,ymax=5] % limits the size of the axes
\tkzDrawX[>=latex]
\tkzDrawY[>=latex]
\tkzDefPoint(0,0){A}
\tkzDefPoint(4,0){B}
\tkzDefPoint(0,3){C}
\tkzDrawPolygon(A,B,C)
\tkzDrawPoints(A,B,C)
\end{tikzpicture}
```

#### 7.1.2. Calculations with xfp




```
\begin{tikzpicture}[scale=1]
  \tkzInit[xmax=4,ymax=4]
  \tkzDrawX\tkzDrawY
  \tkzDefPoint(-1+2,sqrt(4)){O}
  \tkzDefPoint({3*ln(exp(1))},{exp(1)}){A}
  \tkzDefPoint({4*sin(pi/6)},{4*cos(pi/6)}){B}
  \tkzDrawPoints(O,B,A)
\end{tikzpicture}
```

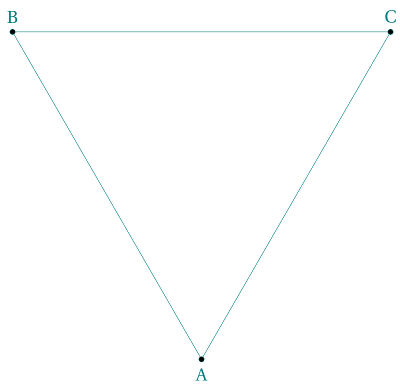
#### 7.1.3. Polar coordinates



```
\begin{tikzpicture}
\foreach \an [count=\i] in {0,60,...,300}
 { \tkzDefPoint(\an:3){A_\i}}
\tkzDrawPolygon(A_1,A_...,A_6)
\tkzDrawPoints(A_1,A_...,A_6)
\end{tikzpicture}
```

#### 7.1.4. Relative points

First, we can use the **scope** environment from Ti*k*Z. In the following example, we have a way to define an equilateral triangle.




```
\begin{tikzpicture}[scale=1]
 \begin{scope}[rotate=30]
  \tkzDefPoint(2,3){A}
  \begin{scope}[shift=(A)]
     \tkzDefPoint(90:5){B}
     \tkzDefPoint(30:5){C}
  \end{scope}
 \end{scope}
 \tkzDrawPolygon(A,B,C)
\tkzLabelPoints[above](B,C)
\tkzLabelPoints[below](A)
\tkzDrawPoints(A,B,C)
\end{tikzpicture}
```

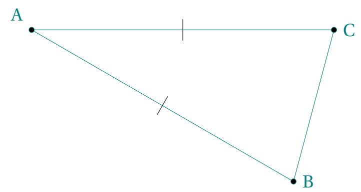
### 7.2. Point relative to another: \tkzDefShiftPoint

**\tkzDefShiftPoint[⟨Point⟩](⟨x,y⟩){⟨ref⟩} or (⟨α:d⟩){⟨ref⟩}**

| arguments | default | definition |
|---|---|---|
| (x,y) | no default | x and y are two dimensions, by default in cm. |
| (α:d) | no default | α is an angle in degrees, d is a dimension |
| {ref} | no default | Reference assigned to the point: A, T_a ,P1 or $P_1$ |
| **options** | **default** | **definition** |
| [pt] | no default | \tkzDefShiftPoint[A](0:4){B} |

### 7.2.1. Isosceles triangle

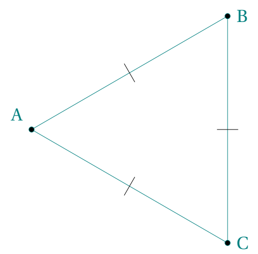
This macro allows you to place one point relative to another. This is equivalent to a translation. Here is how to construct an isosceles triangle with main vertex A and angle at vertex of 30°.




```
\begin{tikzpicture}[rotate=-30]
 \tkzDefPoint(2,3){A}
 \tkzDefShiftPoint[A](0:4){B}
 \tkzDefShiftPoint[A](30:4){C}
 \tkzDrawSegments(A,B B,C C,A)
 \tkzMarkSegments[mark=|](A,B A,C)
 \tkzDrawPoints(A,B,C)
 \tkzLabelPoints[right](B,C)
 \tkzLabelPoints[above left](A)
\end{tikzpicture}
```

### 7.2.2. Equilateral triangle

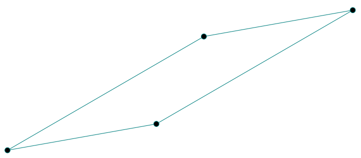
Let's see how to get an equilateral triangle (there is much simpler)




```
\begin{tikzpicture}[scale=1]
 \tkzDefPoint(2,3){A}
 \tkzDefShiftPoint[A](30:3){B}
 \tkzDefShiftPoint[A](-30:3){C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPoints(A,B,C)
 \tkzLabelPoints[right](B,C)
 \tkzLabelPoints[above left](A)
 \tkzMarkSegments[mark=|](A,B A,C B,C)
\end{tikzpicture}
```

### 7.2.3. Parallelogram

There's a simpler way



```
\begin{tikzpicture}
 \tkzDefPoint(0,0){A}
 \tkzDefPoint(30:3){B}
 \tkzDefShiftPointCoord[B](10:2){C}
 \tkzDefShiftPointCoord[A](10:2){D}
 \tkzDrawPolygon(A,...,D)
 \tkzDrawPoints(A,...,D)
\end{tikzpicture}
```

### 7.3. Definition of multiple points: \tkzDefPoints

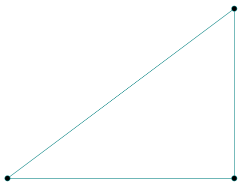
`\tkzDefPoints[⟨local options⟩]{⟨x1/y1/n1,x2/y2/r2, ...⟩}`

$x_i$ and $y_i$ are the coordinates of a referenced point $r_i$

| arguments | default | example |
|---|---|---|
| $x_i/y_i/r_i$ | | `\tkzDefPoints{0/0/O,2/2/A}` |

| options | default | definition |
|---|---|---|
| shift | no default | Adds (x,y) or ($\alpha$:d) to all coordinates |

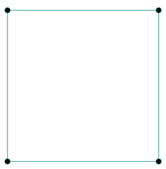
### 7.4. Create a triangle



```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoints{0/0/A,4/0/B,4/3/C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPoints(A,B,C)
\end{tikzpicture}
```

### 7.5. Create a square

Note here the syntax for drawing the polygon.



```
\begin{tikzpicture}[scale=1]
 \tkzDefPoints{0/0/A,2/0/B,2/2/C,0/2/D}
 \tkzDrawPolygon(A,...,D)
 \tkzDrawPoints(A,...,D)
\end{tikzpicture}
```

# Part III.

# Calculating

Now that the fixed points are defined, we can with their references using macros from the package or macros that you will create get new points. The calculations may not be apparent but they are usually done by the package. You may need to use some mathematical constants, here is the list of constants defined by the package.

# 8. Auxiliary tools

## 8.1. Constants

**tkz-euclide** knows some constants, here is the list:

```
\def\tkzPhi{1.618034}
\def\tkzInvPhi{0.618034}
\def\tkzSqrtPhi{1.27202}
\def\tkzSqrTwo{1.414213}
\def\tkzSqrThree{1.7320508}
\def\tkzSqrFive{2.2360679}
\def\tkzSqrTwobyTwo{0.7071065}
\def\tkzPi{3.1415926}
\def\tkzEuler{2.71828182}
```

## 8.2. New point by calculation

When a macro of **tkznameofpack** creates a new point, it is stored internally with the reference **tkzPointResult**. You can assign your own reference to it. This is done with the macro `\tkzGetPoint`. A new reference is created, your choice of reference must be placed between braces.

`\tkzGetPoint{⟨ref⟩}`

If the result is in **tkzPointResult**, you can access it with **\tkzGetPoint**.

| arguments | default | example | |
|---|---|---|---|
| ref | no default | \tkzGetPoint{M} | see the next example |

Sometimes you need to get two points. It's possible with

`\tkzGetPoints{⟨ref1⟩}{⟨ref2⟩}`

The result is in **tkzPointFirstResult** and **tkzPointSecondResult**.

| arguments | default | example | |
|---|---|---|---|
| {ref1,ref2} | no default | \tkzGetPoints{M,N} | It's the case with \tkzInterCC |

If you need only the first or the second point you can also use :

`\tkzGetFirstPoint{⟨ref1⟩}`

| arguments | default | example |
|---|---|---|
| ref1 | no default | \tkzGetFirstPoint{M} |

\tkzGetSecondPoint{⟨ref2⟩}

| arguments | default | example |
|---|---|---|
| ref2 | no default | \tkzGetSecondPoint{M} |

Sometimes the results consist of a point and a dimension. You get the point with `\tkzGetPoint` and the dimension with `\tkzGetLength`.

\tkzGetLength{⟨name of a macro⟩}

| arguments | default | example |
|---|---|---|
| name of a macro | no default | \tkzGetLength{rAB} \rAB gives the length in cm |

## 9. Special points

Here are some special points.

### 9.1. Middle of a segment \tkzDefMidPoint

It is a question of determining the middle of a segment.

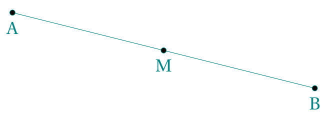
\tkzDefMidPoint(⟨pt1,pt2⟩)

The result is in `tkzPointResult`. We can access it with `\tkzGetPoint`.

| arguments | default | definition |
|---|---|---|
| (pt1,pt2) | no default | pt1 and pt2 are two points |

#### 9.1.1. Use of \tkzDefMidPoint

Review the use of `\tkzDefPoint`.




```
\begin{tikzpicture}[scale=1]
 \tkzDefPoint(2,3){A}
 \tkzDefPoint(6,2){B}
 \tkzDefMidPoint(A,B)
 \tkzGetPoint{M}
 \tkzDrawSegment(A,B)
 \tkzDrawPoints(A,B,M)
 \tkzLabelPoints[below](A,B,M)
\end{tikzpicture}
```

### 9.2. Golden ratio \tkzDefGoldenRatio

From Wikipedia : In mathematics, two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. Expressed algebraically, for quantities a, b such as $a > b > 0$; $a + b$ is to a as a is to b.

$\frac{a+b}{a} = \frac{a}{b} = \phi = \frac{1+\sqrt{5}}{2}$

One of the two solutions to the equation $x^2 - x - 1 = 0$ is the golden ratio $\phi$, $\phi = \frac{1+\sqrt{5}}{2}$.

`\tkzDefGoldenRatio(⟨pt1,pt2⟩)`

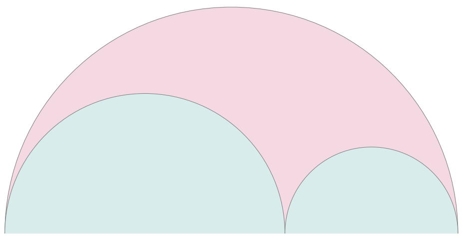
| arguments | default | example |
|---|---|---|
| `(pt1,pt2)` | `no default` | `\tkzDefGoldenRatio(A,C) \tkzGetPoint{B}` |

$AB = a$, $BC = b$ and $\frac{AC}{AB} = \frac{AB}{BC} = \phi$

### 9.2.1. Use the golden ratio to divide a line segment


```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,6/0/C}
 \tkzDefMidPoint(A,C) \tkzGetPoint{I}
 %\tkzDefPointWith[linear,K=\tkzInvPhi](A,C)
 \tkzDefGoldenRatio(A,C) \tkzGetPoint{B}
 \tkzDrawSegments(A,C)
 \tkzDrawPoints(A,B,C)
 \tkzLabelPoints(A,B,C)
\end{tikzpicture}
```

### 9.2.2. Golden arbelos



```
\begin{tikzpicture}[scale=.6]
\tkzDefPoints{0/0/A,10/0/B}
\tkzDefGoldenRatio(A,B)      \tkzGetPoint{C}
\tkzDefMidPoint(A,B)         \tkzGetPoint{O_1}
\tkzDefMidPoint(A,C)         \tkzGetPoint{O_2}
\tkzDefMidPoint(C,B)         \tkzGetPoint{O_3}
\tkzDrawSemiCircles[fill=purple!15](O_1,B)
\tkzDrawSemiCircles[fill=teal!15](O_2,C O_3,B)
\end{tikzpicture}
```

It is also possible to use the following macro.

## 9.3. Barycentric coordinates with \tkzDefBarycentricPoint

$pt_1, pt_2, \ldots, pt_n$ being n points, they define n vectors $\overrightarrow{v_1}, \overrightarrow{v_2}, \ldots, \overrightarrow{v_n}$ with the origin of the referential as the common endpoint. $\alpha_1, \alpha_2, \ldots \alpha_n$ are n numbers, the vector obtained by:

$$\frac{\alpha_1\overrightarrow{v_1} + \alpha_2\overrightarrow{v_2} + \cdots + \alpha_n\overrightarrow{v_n}}{\alpha_1 + \alpha_2 + \cdots + \alpha_n}$$

defines a single point.

`\tkzDefBarycentricPoint(⟨pt1=`$\alpha_1$`,pt2=`$\alpha_2$`,...⟩)`

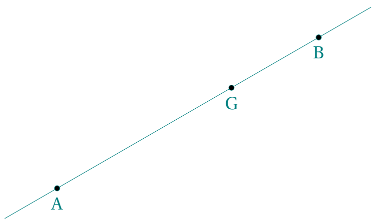
| arguments | default | definition |
|---|---|---|
| `(pt1=`$\alpha_1$`,pt2=`$\alpha_2$`,...)` | `no default` | `Each point has a assigned weight` |

*You need at least two points. Result in* `tkzPointResult`.

### 9.3.1. with two points

In the following example, we obtain the barycenter of points A and B with coefficients 1 and 2, in other words:

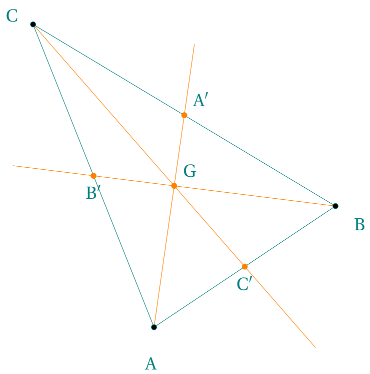
$$\overrightarrow{AI} = \frac{2}{3}\overrightarrow{AB}$$




```
\begin{tikzpicture}
  \tkzDefPoint(2,3){A}
  \tkzDefShiftPointCoord[2,3](30:4){B}
  \tkzDefBarycentricPoint(A=1,B=2)
  \tkzGetPoint{G}
  \tkzDrawLine(A,B)
  \tkzDrawPoints(A,B,G)
  \tkzLabelPoints(A,B,G)
\end{tikzpicture}
```

### 9.3.2. with three points

This time M is simply the center of gravity of the triangle.
For reasons of simplification and homogeneity, there is also `\tkzCentroid`.




```
\begin{tikzpicture}[scale=.8]
  \tkzDefPoints{2/1/A,5/3/B,0/6/C}
  \tkzDefBarycentricPoint(A=1,B=1,C=1)
  \tkzGetPoint{G}
  \tkzDefMidPoint(A,B)  \tkzGetPoint{C'}
  \tkzDefMidPoint(A,C)  \tkzGetPoint{B'}
  \tkzDefMidPoint(C,B)  \tkzGetPoint{A'}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawLines[add=0 and 1,new](A,G B,G C,G)
  \tkzDrawPoints[new](A',B',C',G)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoint[above right](G){$G$}
  \tkzAutoLabelPoints[center=G](A,B,C)
  \tkzLabelPoints[above right](A')
  \tkzLabelPoints[below](B',C')
\end{tikzpicture}
```

## 9.4. Internal and external Similitude Center

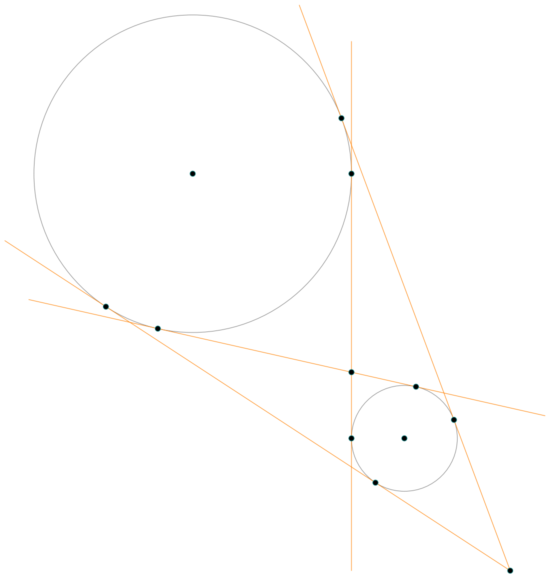
The centers of the two homotheties in which two circles correspond are called external and internal centers of similitude. You can use `\tkzDefIntSimilitudeCenter` and `\tkzDefExtSimilitudeCenter` but the next macro is better.

`\tkzDefSimilitudeCenter[⟨options⟩](⟨O,A⟩)(⟨O',B⟩)`

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩)(⟨pt3,pt4⟩) | (O,A)(O′,B) | $r = OA, r' = O'B$ |

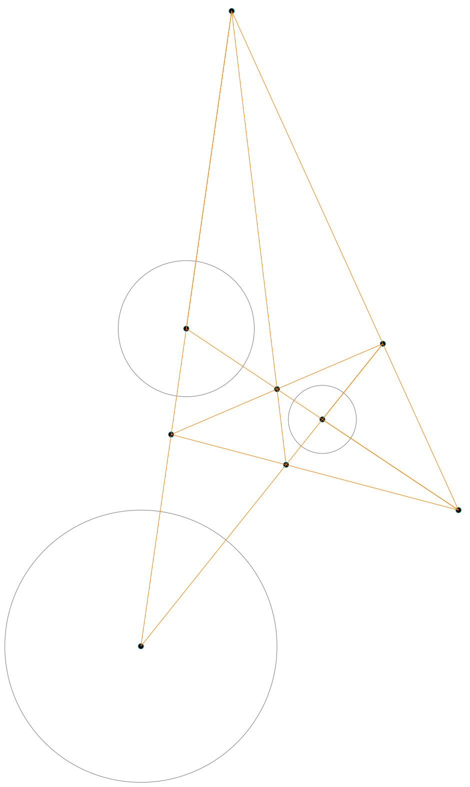
| options | default | definition |
|---|---|---|
| ext | ext | external center |
| int | ext | internal center |

### 9.4.1. Internal and external with node



```
\begin{tikzpicture}[scale=.7]
 \tkzDefPoints{0/0/O,4/-5/A,3/0/B,5/-5/C}
 \tkzDefSimilitudeCenter[int](O,B)(A,C)
 \tkzGetPoint{I}
 \tkzDefSimilitudeCenter[ext](O,B)(A,C)
 \tkzGetPoint{J}
 \tkzDefLine[tangent from = I](O,B)
 \tkzGetPoints{D}{E}
 \tkzDefLine[tangent from = I](A,C)
 \tkzGetPoints{D'}{E'}
 \tkzDefLine[tangent from = J](O,B)
 \tkzGetPoints{F}{G}
 \tkzDefLine[tangent from = J](A,C)
 \tkzGetPoints{F'}{G'}
 \tkzDrawCircles(O,B A,C)
 \tkzDrawSegments[add = .5 and .5,new](D,D' E,E')
 \tkzDrawSegments[add= 0 and 0.25,new](J,F J,G)
 \tkzDrawPoints(O,A,I,J,D,E,F,G,D',E',F',G')
\end{tikzpicture}
```

### 9.4.2. D'Alembert Theorem

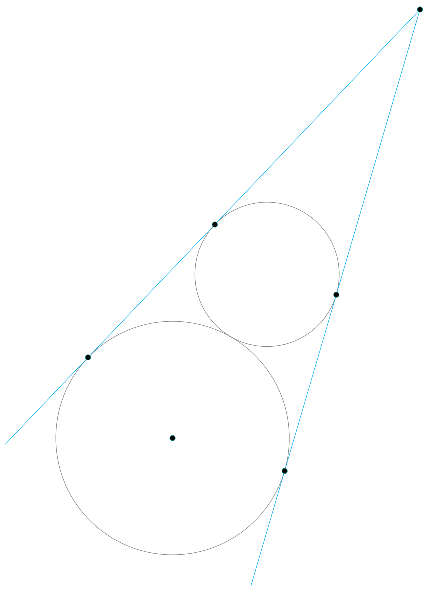


```
\begin{tikzpicture}[scale=.6,rotate=90]
\tkzDefPoints{0/0/A,3/0/a,7/-1/B,5.5/-1/b}
\tkzDefPoints{5/-4/C,4.25/-4/c}
\tkzDrawCircles(A,a B,b C,c)
\tkzDefExtSimilitudeCenter(A,a)(B,b) \tkzGetPoint{I}
\tkzDefExtSimilitudeCenter(A,a)(C,c) \tkzGetPoint{J}
\tkzDefExtSimilitudeCenter(C,c)(B,b) \tkzGetPoint{K}
\tkzDefIntSimilitudeCenter(A,a)(B,b) \tkzGetPoint{I'}
\tkzDefIntSimilitudeCenter(A,a)(C,c) \tkzGetPoint{J'}
\tkzDefIntSimilitudeCenter(C,c)(B,b) \tkzGetPoint{K'}
\tkzDrawPoints(A,B,C,I,J,K,I',J',K')
\tkzDrawSegments[new](I,K A,I A,J B,I B,K C,J C,K)
\tkzDrawSegments[new](I,J' I',J I',K)
\end{tikzpicture}
```

You can use `\tkzDefBarycentricPoint` to find a homothetic center

```
\tkzDefBarycentricPoint(O=\r,A=\R)      \tkzGetPoint{I}
\tkzDefBarycentricPoint(O={-\r},A=\R)   \tkzGetPoint{J}
```

### 9.4.3. Example with node



```
\begin{tikzpicture}[rotate=60,scale=.5]
 \tkzDefPoints{0/0/A,5/0/C}
 \tkzDefGoldenRatio(A,C) \tkzGetPoint{B}
 \tkzDefSimilitudeCenter(A,B)(C,B)\tkzGetPoint{J}
 \tkzDefTangent[from = J](A,B)  \tkzGetPoints{F}{G}
 \tkzDefTangent[from = J](C,B)  \tkzGetPoints{F'}{G'}
 \tkzDrawCircles(A,B C,B)
 \tkzDrawSegments[add= 0 and 0.25,cyan](J,F J,G)
 \tkzDrawPoints(A,J,F,G,F',G')
\end{tikzpicture}
```

## 9.5. Harmonic division with \tkzDefHarmonic

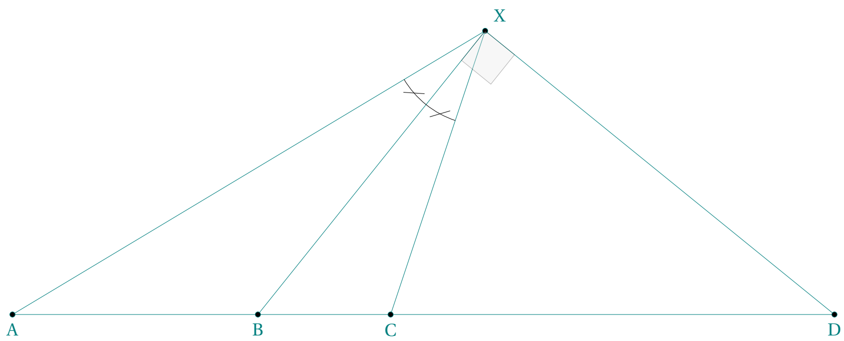
\tkzDefHarmonic[⟨options⟩](⟨pt1,pt2,pt3⟩) or (⟨pt1,pt2,k⟩)

| options | default | definition |
|---|---|---|
| both | both | (⟨A,B,2⟩) we look for C and D such that $(A,B;C,D) = -1$ and CA=2CB |
| ext | both | (⟨A,B,C⟩) we look for D such that $(A,B;C,D) = -1$ |
| int | both | (⟨A,B,D⟩) we look for C such that $(A,B;C,D) = -1$ |

### 9.5.1. options ext and int


```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,6/0/B,4/0/C}
\tkzDefHarmonic[ext](A,B,C) \tkzGetPoint{J}
\tkzDefHarmonic[int](A,B,J) \tkzGetPoint{I}
\tkzDrawPoints(A,B,I,J)
\tkzDrawLine[add=.5 and 1](A,B)
\tkzLabelPoints(A,B,I,J)
\end{tikzpicture}
```

### 9.5.2. Bisector and harmonic division




```
\begin{tikzpicture}[scale=1.25]
\tkzDefPoints{0/0/A,4/0/C,5/3/X}
\tkzDefLine[bisector](A,X,C) \tkzGetPoint{x}
\tkzInterLL(X,x)(A,C)        \tkzGetPoint{B}
\tkzDefHarmonic[ext](A,C,B)  \tkzGetPoint{D}
\tkzDrawPolygon(A,X,C)
\tkzDrawSegments(X,B C,D D,X)
\tkzDrawPoints(A,B,C,D,X)
\tkzMarkAngles[mark=s|](A,X,B B,X,C)
\tkzMarkRightAngle[size=.4,
                   fill=gray!20,
                   opacity=.3](B,X,D)
\tkzLabelPoints(A,B,C,D)
\tkzLabelPoints[above right](X)
\end{tikzpicture}
```

#### 9.5.3. option both

both is the default option


```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,6/0/B}
 \tkzDefHarmonic(A,B,{1/2})\tkzGetPoints{I}{J}
 \tkzDrawPoints(A,B,I,J)
 \tkzDrawLine[add=1 and .5](A,B)
 \tkzLabelPoints(A,B,I,J)
\end{tikzpicture}
```

### 9.6. Equidistant points with \tkzDefEquiPoints

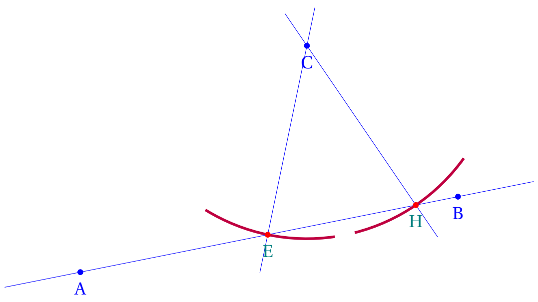
\tkzDefEquiPoints[⟨local options⟩](⟨pt1,pt2⟩)

| arguments | default | definition |
|---|---|---|
| (pt1,pt2) | no default | unordered list of two items |

| options | default | definition |
|---|---|---|
| dist | 2 (cm) | half the distance between the two points |
| from=pt | no default | reference point |
| show | false | if true displays compass traces |
| /compass/delta | 0 | compass trace size |

*This macro makes it possible to obtain two points on a straight line equidistant from a given point.*

#### 9.6.1. Using \tkzDefEquiPoints with options

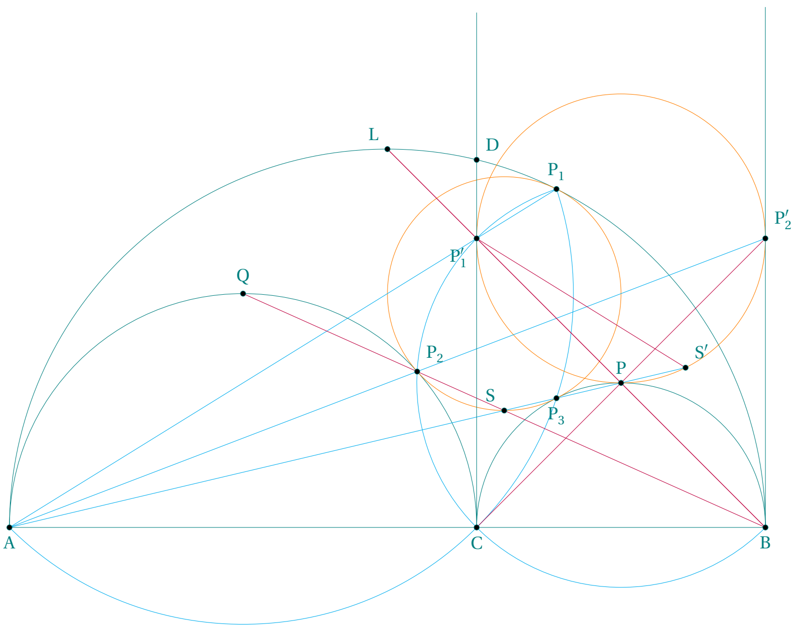



```
\begin{tikzpicture}
  \tkzSetUpCompass[color=purple,line width=1pt]
  \tkzDefPoints{0/1/A,5/2/B,3/4/C}
  \tkzDefEquiPoints[from=C,dist=1,show,
      /tkzcompass/delta=20](A,B)
   \tkzGetPoints{E}{H}
   \tkzDrawLines[color=blue](C,E C,H A,B)
   \tkzDrawPoints[color=blue](A,B,C)
   \tkzDrawPoints[color=red](E,H)
   \tkzLabelPoints(E,H)
   \tkzLabelPoints[color=blue](A,B,C)
\end{tikzpicture}
```

### 9.7. Middle of an arc

\tkzDefMidArc(⟨pt1,pt2,pt3⟩)

| arguments | default | definition |
|---|---|---|
| pt1,pt2,pt3 | no default | pt1 is the center, $\overparen{pt2pt3}$ the arc |


L
D
P1
P'2
Q
P'1
P2
S'
P
S
P3
A
C
B

```
\begin{tikzpicture}[scale=1]
 \tkzDefPoints{0/0/A,10/0/B}
 \tkzDefGoldenRatio(A,B)                            \tkzGetPoint{C}
 \tkzDefMidPoint(A,B)                               \tkzGetPoint{O_1}
 \tkzDefMidPoint(A,C)                               \tkzGetPoint{O_2}
 \tkzDefMidPoint(C,B)                               \tkzGetPoint{O_3}
 \tkzDefMidArc(O_3,B,C)                             \tkzGetPoint{P}
 \tkzDefMidArc(O_2,C,A)                             \tkzGetPoint{Q}
 \tkzDefMidArc(O_1,B,A)                             \tkzGetPoint{L}
 \tkzDefPointBy[rotation=center C angle 90](B)      \tkzGetPoint{c}
 \tkzInterCC[common=B](P,B)(O_1,B)                  \tkzGetFirstPoint{P_1}
 \tkzInterCC[common=C](P,C)(O_2,C)                  \tkzGetFirstPoint{P_2}
 \tkzInterCC[common=C](Q,C)(O_3,C)                  \tkzGetFirstPoint{P_3}
 \tkzInterLC[near](c,C)(O_1,A)                      \tkzGetFirstPoint{D}
 \tkzInterLL(A,P_1)(C,D)                            \tkzGetPoint{P_1'}
 \tkzDefPointBy[inversion = center A through D](P_2)  \tkzGetPoint{P_2'}
 \tkzDefCircle[circum](P_3,P_2,P_1)                 \tkzGetPoint{O_4}
 \tkzInterLL(B,Q)(A,P)                              \tkzGetPoint{S}
 \tkzDefMidPoint(P_2',P_1')                         \tkzGetPoint{o}
 \tkzDefPointBy[inversion = center A through D](S)  \tkzGetPoint{S'}
 \tkzDrawArc[cyan,delta=0](Q,A)(P_1)
 \tkzDrawArc[cyan,delta=0](P,P_1)(B)
 \tkzDrawSemiCircles[teal](O_1,B O_2,C O_3,B)
 \tkzDrawCircles[new](o,P O_4,P_1)
 \tkzDrawSegments(A,B)
 \tkzDrawSegments[cyan](A,P_1 A,S' A,P_2')
 \tkzDrawSegments[purple](B,L C,P_2' B,Q B,L S',P_1')
 \tkzDrawLines[add=0 and .8](B,P_2')
 \tkzDrawLines[add=0 and .4](C,D)
 \tkzDrawPoints(A,B,C,P,Q,P_3,P_2,P_1,P_1',D,P_2',L,S,S')
 \tkzLabelPoints(A,B,C,P_3)
 \tkzLabelPoints[above](P,Q,P_1)
 \tkzLabelPoints[above right](P_2,P_2',D,S')
 \tkzLabelPoints[above left](L,S)
  \tkzLabelPoints[below left](P_1')
\end{tikzpicture}
```

## 10. Point on line or circle

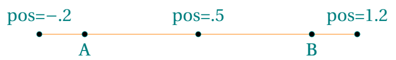
### 10.1. Point on a line with \tkzDefPointOnLine

**\tkzDefPointOnLine[⟨local options⟩](⟨A,B⟩)**

| arguments | default | definition |
|---|---|---|
| pt1,pt2 | no default | Two points to define a line |

| options | default | definition |
|---|---|---|
| pos=nb | | nb is a decimal |

#### 10.1.1. Use of option pos




```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,3/0/B}
\tkzDefPointOnLine[pos=1.2](A,B)\tkzGetPoint{P}
\tkzDefPointOnLine[pos=-0.2](A,B)\tkzGetPoint{R}
\tkzDefPointOnLine[pos=0.5](A,B) \tkzGetPoint{S}
\tkzDrawLine[new](A,B)
\tkzDrawPoints(A,B,P)
\tkzLabelPoints(A,B)
\tkzLabelPoint[above](P){pos=$1.2$}
\tkzLabelPoint[above](R){pos=$-.2$}
\tkzLabelPoint[above](S){pos=$.5$}
\tkzDrawPoints(A,B,P,R,S)
\tkzLabelPoints(A,B)
\end{tikzpicture}
```

### 10.2. Point on a circle with \tkzDefPointOnCircle

The order of the arguments has changed: now it is center, angle and point or radius. I have added two options for working with radians which are `through in rad` and `R in rad`.

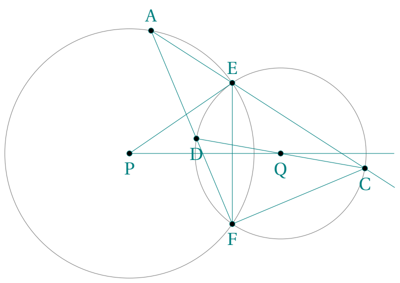
`\tkzDefPointOnCircle[⟨local options⟩]`

| options | default | examples definition |
|---|---|---|
| through | | through = center K1 angle 30 point B] |
| R | | R = center K1 angle 30 radius \rAp |
| through in rad | | through in rad= center K1 angle pi/4 point B] |
| R in rad | | R in rad = center K1 angle pi/6 radius \rAp |

*The new order for arguments are : center, angle and point or radius.*

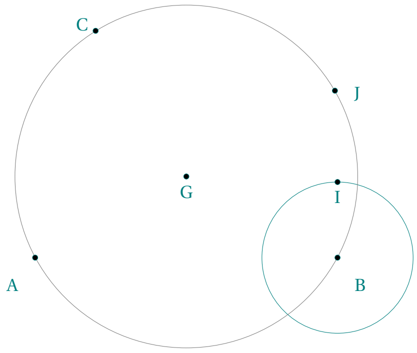
#### 10.2.1. Altshiller's Theorem

The two lines joining the points of intersection of two orthogonal circles to a point on one of the circles met the other circle in two diametricaly oposite points. Altshiller p 176




```
\begin{tikzpicture}[scale=.4]
\tkzDefPoints{0/0/P,5/0/Q,3/2/I}
\tkzDefCircle[orthogonal from=P](Q,I)
\tkzGetFirstPoint{E}
\tkzDrawCircles(P,E Q,E)
\tkzInterCC[common=E](P,E)(Q,E) \tkzGetFirstPoint{F}
\tkzDefPointOnCircle[through =  center P angle 80 point E]
 \tkzGetPoint{A}
\tkzInterLC[common=E](A,E)(Q,E)  \tkzGetFirstPoint{C}
\tkzInterLL(A,F)(C,Q)  \tkzGetPoint{D}
\tkzDrawLines[add=0 and .75](P,Q)
\tkzDrawLines[add=0 and 2](A,E)
\tkzDrawSegments(P,E E,F F,C A,F C,D)
\tkzDrawPoints(P,Q,E,F,A,C,D)
\tkzLabelPoints(P,Q,F,C,D)
\tkzLabelPoints[above](E,A)
\end{tikzpicture}
```

### 10.2.2. Use of \tkzDefPointOnCircle




```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,4/0/B,0.8/3/C}
\tkzDefPointOnCircle[R = center B  angle 90 radius 1]
\tkzGetPoint{I}
\tkzDefCircle[circum](A,B,C)
\tkzGetPoints{G}{g}
\tkzDefPointOnCircle[through = center G angle 30 point g]
\tkzGetPoint{J}
\tkzDefCircle[R](B,1) \tkzGetPoint{b}
\tkzDrawCircle[teal](B,b)
\tkzDrawCircle(G,J)
\tkzDrawPoints(A,B,C,G,I,J)
\tkzAutoLabelPoints[center=G](A,B,C,J)
\tkzLabelPoints[below](G,I)
\end{tikzpicture}
```

# 11. Special points relating to a triangle

## 11.1. Triangle center: \tkzDefTriangleCenter

`\tkzDefTriangleCenter[⟨local options⟩](⟨A,B,C⟩)`

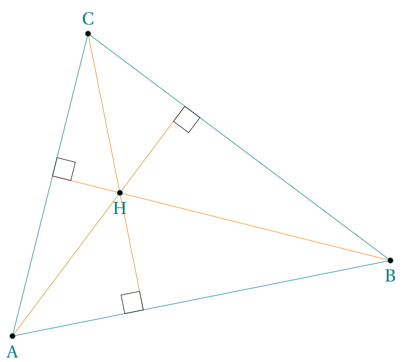
This macro allows you to define the center of a triangle.. Be careful, the arguments are lists of three points. This macro is used in conjunction with `\tkzGetPoint` to get the center you are looking for.
You can use `tkzPointResult` if it is not necessary to keep the results.

| arguments | default | example |
|---|---|---|
| (pt1,pt2,pt3) | no default | \tkzDefTriangleCenter[ortho](B,C,A) |

| options | default | definition |
|---|---|---|
| ortho | circum | intersection of the altitudes |
| orthic | circum | … |
| centroid | circum | intersection of the medians |
| median | circum | … |
| circum | circum | circle center circumscribed |
| in | circum | center of the circle inscribed in a triangle |
| in | circum | intersection of the bisectors |
| ex | circum | center of a circle exinscribed to a triangle |
| euler | circum | center of Euler's circle |
| gergonne | circum | defined with the Contact triangle |
| symmedian | circum | Lemoine's point or symmedian center or Grebe's point |
| lemoine | circum | … |
| grebe | circum | … |
| spieker | circum | Spieker circle center |
| nagel | circum | Nagel Center |
| mittenpunkt | circum | Or middlespoint |
| feuerbach | circum | Feuerbach Point |

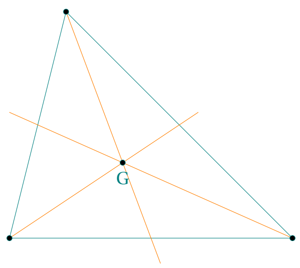
### 11.1.1. Option ortho or orthic

The intersection H of the three altitudes of a triangle is called the orthocenter.



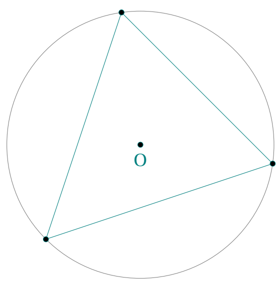

```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(5,1){B}
  \tkzDefPoint(1,4){C}
  \tkzDefTriangleCenter[ortho](B,C,A)
  \tkzGetPoint{H}
  \tkzDefSpcTriangle[orthic,name=H](A,B,C){a,b,c}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawSegments[new](A,Ha B,Hb C,Hc)
  \tkzDrawPoints(A,B,C,H)
  \tkzLabelPoint(H){$H$}
  \tkzLabelPoints[below](A,B)
  \tkzLabelPoints[above](C)
 \tkzMarkRightAngles(A,Ha,B B,Hb,C C,Hc,A)
\end{tikzpicture}
```

### 11.1.2. Option centroid




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/A,5/0/B,1/4/C}
  \tkzDefTriangleCenter[centroid](A,B,C)
  \tkzGetPoint{G}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawLines[add = 0 and 2/3,new](A,G B,G C,G)
  \tkzDrawPoints(A,B,C,G)
  \tkzLabelPoint(G){$G$}
\end{tikzpicture}
```

### 11.1.3. Option circum

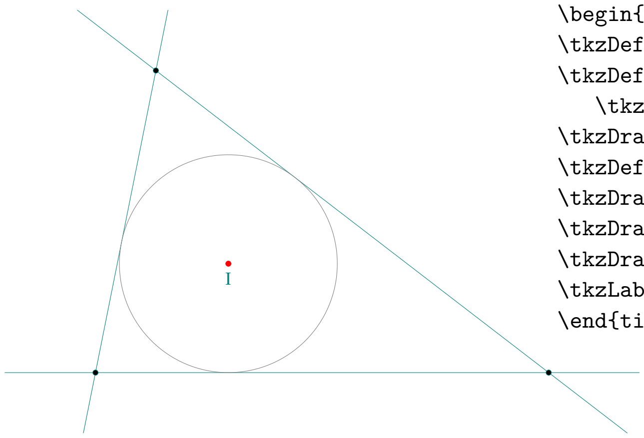



```
 \begin{tikzpicture}
  \tkzDefPoints{0/1/A,3/2/B,1/4/C}
  \tkzDefTriangleCenter[circum](A,B,C)
  \tkzGetPoint{O}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawCircle(O,A)
  \tkzDrawPoints(A,B,C,O)
  \tkzLabelPoint(O){$O$}
\end{tikzpicture}
```

### 11.1.4. Option in

In geometry, the incircle or inscribed circle of a triangle is the largest circle contained in the triangle; it touches (is tangent to) the three sides. The center of the incircle is a triangle center called the triangle's incenter. The center of the incircle, called the incenter, can be found as the intersection of the three internal angle bisectors. The center of an excircle is the intersection of the internal bisector of one angle (at vertex A, for example) and the external bisectors of the other two. The center of this excircle is called the excenter relative to the vertex A, or the excenter of A. Because the internal bisector of an angle is perpendicular to its external bisector, it follows that the center of the incircle together with the three excircle centers form an orthocentric system.
(Article on Wikipedia)

We get the center of the inscribed circle of the triangle. The result is of course in **tkzPointResult**. We can retrieve it with `\tkzGetPoint`.

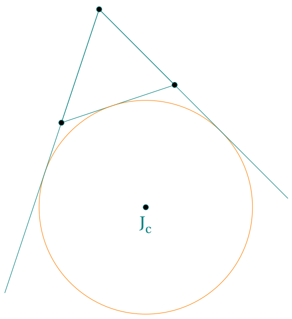



```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
\tkzDefTriangleCenter[in](A,B,C)
   \tkzGetPoint{I}
\tkzDrawLines(A,B B,C C,A)
\tkzDefCircle[in](A,B,C) \tkzGetPoints{I}{i}
\tkzDrawCircle(I,i)
\tkzDrawPoint[red](I)
\tkzDrawPoints(A,B,C)
\tkzLabelPoint(I){$I$}
\end{tikzpicture}
```

### 11.1.5. Option ex

An excircle or escribed circle of the triangle is a circle lying outside the triangle, tangent to one of its sides and tangent to the extensions of the other two. Every triangle has three distinct excircles, each tangent to one of the

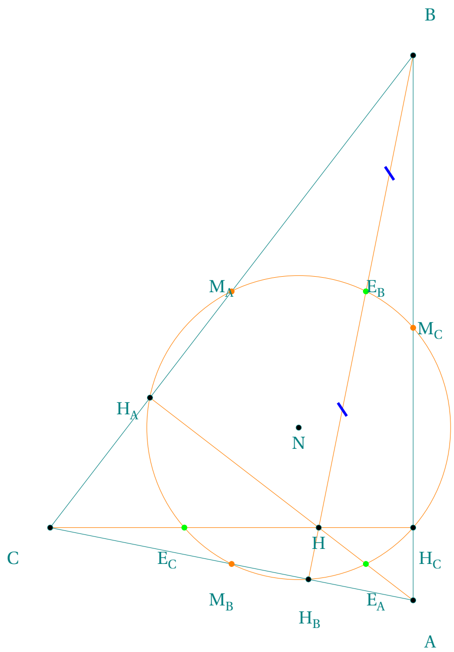
triangle's sides.
(Article on Wikipedia)
We get the center of an inscribed circle of the triangle. The result is of course in **tkzPointResult**. We can retrieve it with `\tkzGetPoint`.




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{0/1/A,3/2/B,1/4/C}
  \tkzDefTriangleCenter[ex](B,C,A)
  \tkzGetPoint{J_c}
  \tkzDefPointBy[projection=onto A--B](J_c)
  \tkzGetPoint{Tc}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawCircle[new](J_c,Tc)
  \tkzDrawLines[add=1.5 and 0](A,C B,C)
  \tkzDrawPoints(A,B,C,J_c)
  \tkzLabelPoints(J_c)
\end{tikzpicture}
```

### 11.1.6. Option **euler**

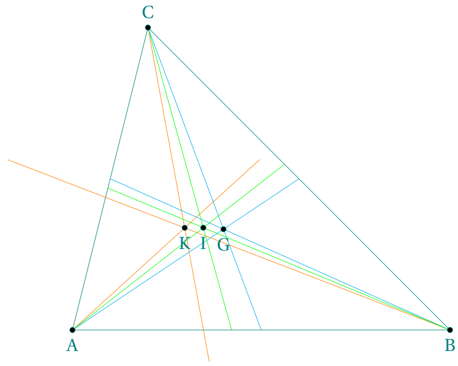
This macro allows to obtain the center of the circle of the nine points or euler's circle or Feuerbach's circle. The nine-point circle, also called Euler's circle or the Feuerbach circle, is the circle that passes through the perpendicular feet $H_A$, $H_B$, and $H_C$ dropped from the vertices of any reference triangle ABC on the sides opposite them. Euler showed in 1765 that it also passes through the midpoints $M_A$, $M_B$, $M_C$ of the sides of ABC. By Feuerbach's theorem, the nine-point circle also passes through the midpoints $E_A$, $E_B$, and $E_C$ of the segments that join the vertices and the orthocenter H. These points are commonly referred to as the Euler points.
(`https://mathworld.wolfram.com/Nine-PointCircle.html`)




```
\begin{tikzpicture}[scale=1.2,rotate=90]
 \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
 \tkzDefSpcTriangle[medial,name=M](A,B,C){_A,_B,_C}
 \tkzDefTriangleCenter[euler](A,B,C)\tkzGetPoint{N}
 % I= N nine points
 \tkzDefTriangleCenter[ortho](A,B,C)\tkzGetPoint{H}
 \tkzDefMidPoint(A,H) \tkzGetPoint{E_A}
 \tkzDefMidPoint(C,H) \tkzGetPoint{E_C}
 \tkzDefMidPoint(B,H) \tkzGetPoint{E_B}
 \tkzDefSpcTriangle[ortho,name=H](A,B,C){_A,_B,_C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawCircle[new](N,E_A)
 \tkzDrawSegments[new](A,H_A B,H_B C,H_C)
 \tkzDrawPoints(A,B,C,N,H)
 \tkzDrawPoints[new](M_A,M_B,M_C)
 \tkzDrawPoints( H_A,H_B,H_C)
 \tkzDrawPoints[green](E_A,E_B,E_C)
 \tkzAutoLabelPoints[center=N,
 font=\scriptsize](A,B,C,M_A,M_B,M_C,H_A,H_B,H_C,%
   E_A,E_B,E_C)
 \tkzLabelPoints[font=\scriptsize](H,N)
 \tkzMarkSegments[mark=s|,size=3pt,
 color=blue,line width=1pt](B,E_B E_B,H)
\end{tikzpicture}
```

### 11.1.7. Option **symmedian**

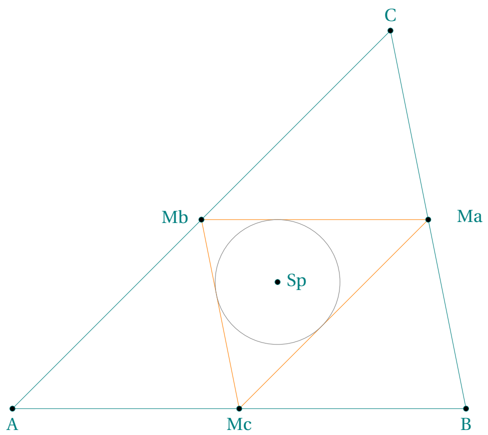
The point of concurrence K of the symmedians, sometimes also called the Lemoine point (in England and France) or the Grebe point (in Germany).
Weisstein, Eric W. "Symmedian Point." From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(5,0){B}
  \tkzDefPoint(1,4){C}
  \tkzDefTriangleCenter[symmedian](A,B,C)
  \tkzGetPoint{K}
  \tkzDefTriangleCenter[median](A,B,C)
  \tkzGetPoint{G}
  \tkzDefTriangleCenter[in](A,B,C)\tkzGetPoint{I}
  \tkzDefSpcTriangle[centroid,name=M](A,B,C){a,b,c}
  \tkzDefSpcTriangle[incentral,name=I](A,B,C){a,b,c}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawLines[add = 0 and 2/3,new](A,K B,K C,K)
  \tkzDrawSegments[color=cyan](A,Ma B,Mb C,Mc)
  \tkzDrawSegments[color=green](A,Ia B,Ib C,Ic)
  \tkzDrawPoints(A,B,C,K,G,I)
  \tkzLabelPoints[font=\scriptsize](A,B,K,G,I)
  \tkzLabelPoints[above,font=\scriptsize](C)
\end{tikzpicture}
```

### 11.1.8. Option spieker

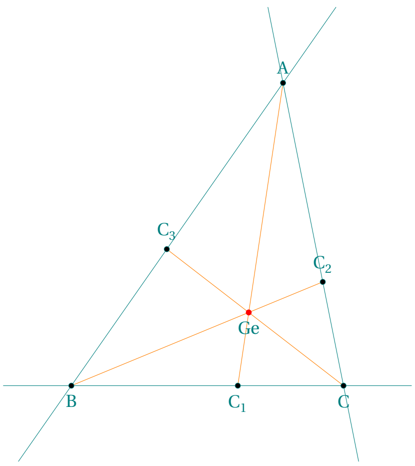
The Spieker center is the center Sp of the Spieker circle, i.e., the incenter of the medial triangle of a reference triangle.
Weisstein, Eric W. "Spieker Center." From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,6/0/B,5/5/C}
 \tkzDefSpcTriangle[medial](A,B,C){Ma,Mb,Mc}
 \tkzDefTriangleCenter[centroid](A,B,C)
 \tkzGetPoint{G}
 \tkzDefTriangleCenter[spieker](A,B,C)
 \tkzGetPoint{Sp}
 \tkzDrawPolygon[](A,B,C)
 \tkzDrawPolygon[new](Ma,Mb,Mc)
 \tkzDefCircle[in](Ma,Mb,Mc) \tkzGetPoints{I}{i}
 \tkzDrawCircle(I,i)
 \tkzDrawPoints(B,C,A,Sp,Ma,Mb,Mc)
 \tkzAutoLabelPoints[center=G,dist=.3](Ma,Mb)
 \tkzLabelPoints[right](Sp)
 \tkzLabelPoints[below](A,B,Mc)
 \tkzLabelPoints[above](C)
\end{tikzpicture}
```

### 11.1.9. Option gergonne

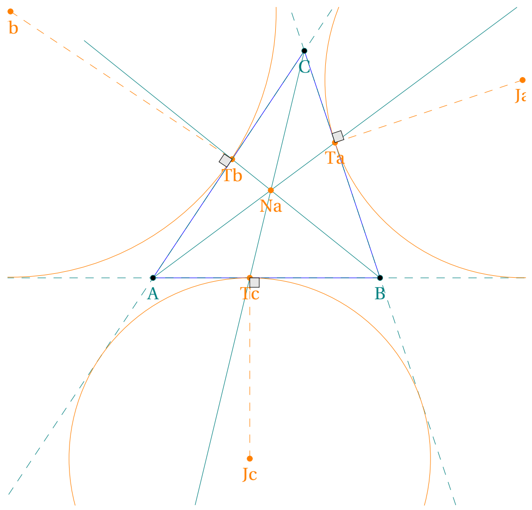
The Gergonne Point is the point of concurrency which results from connecting the vertices of a triangle to the opposite points of tangency of the triangle's incircle. (Joseph Gergonne French mathematician )




```
\begin{tikzpicture}
\tkzDefPoints{0/0/B,3.6/0/C,2.8/4/A}
\tkzDefTriangleCenter[gergonne](A,B,C)
\tkzGetPoint{Ge}
\tkzDefSpcTriangle[intouch](A,B,C){C_1,C_2,C_3}
\tkzDefCircle[in](A,B,C) \tkzGetPoints{I}{i}
\tkzDrawLines[add=.25 and .25,teal](A,B A,C B,C)
\tkzDrawSegments[new](A,C_1 B,C_2 C,C_3)
\tkzDrawPoints(A,...,C,C_1,C_2,C_3)
\tkzDrawPoints[red](Ge)
\tkzLabelPoints(B,C,C_1,Ge)
\tkzLabelPoints[above](A,C_2,C_3)
\end{tikzpicture}
```

### 11.1.10. Option nagel

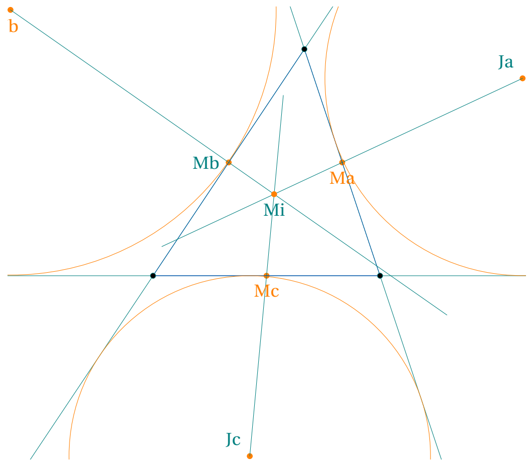
Let Ta be the point at which the excircle with center Ja meets the side BC of a triangle ABC, and define Tb and Tc similarly. Then the lines ATa, BTb, and CTc concur in the Nagel point Na.
Weisstein, Eric W. "Nagel point." From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}[scale=.5]
\tkzDefPoints{0/0/A,6/0/B,4/6/C}
\tkzDefSpcTriangle[ex](A,B,C){Ja,Jb,Jc}
\tkzDefSpcTriangle[extouch](A,B,C){Ta,Tb,Tc}
\tkzDefTriangleCenter[nagel](A,B,C)
\tkzGetPoint{Na}
\tkzDrawPolygon[blue](A,B,C)
\tkzDrawLines[add=0 and 1](A,Ta B,Tb C,Tc)
\tkzDrawPoints[new](Ja,Jb,Jc,Ta,Tb,Tc)
\tkzClipBB
\tkzDrawLines[add=1 and 1,dashed](A,B B,C C,A)
\tkzDrawCircles[new](Ja,Ta Jb,Tb Jc,Tc)
\tkzDrawSegments[new,dashed](Ja,Ta Jb,Tb Jc,Tc)
\tkzDrawPoints(B,C,A)
\tkzDrawPoints[new](Na)
\tkzLabelPoints(B,C,A)
\tkzLabelPoints[new](Na)
\tkzLabelPoints[new](Ja,Jb,Jc,Ta,Tb,Tc)
\tkzMarkRightAngles[fill=gray!20](Ja,Ta,C
          Jb,Tb,A Jc,Tc,B)
\end{tikzpicture}
```

### 11.1.11. Option mittenpunkt

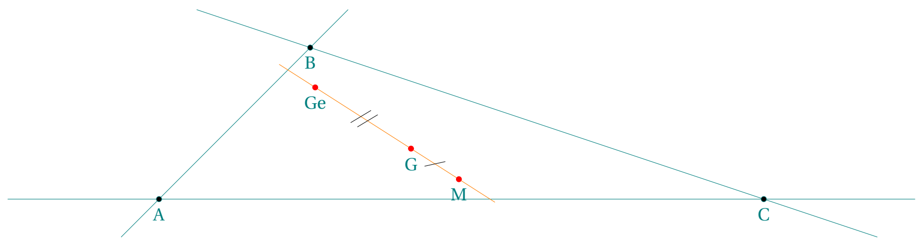
The mittenpunkt (also called the middlespoint) of a triangle ABC is the symmedian point of the excentral triangle, i.e., the point of concurrence M of the lines from the excenters through the corresponding triangle side midpoints.
Weisstein, Eric W. "Mittenpunkt." From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoints{0/0/A,6/0/B,4/6/C}
 \tkzDefSpcTriangle[centroid](A,B,C){Ma,Mb,Mc}
 \tkzDefSpcTriangle[ex](A,B,C){Ja,Jb,Jc}
 \tkzDefSpcTriangle[extouch](A,B,C){Ta,Tb,Tc}
 \tkzDefTriangleCenter[mittenpunkt](A,B,C)
 \tkzGetPoint{Mi}
 \tkzDrawPoints[new](Ma,Mb,Mc,Ja,Jb,Jc)
 \tkzClipBB
 \tkzDrawPolygon[blue](A,B,C)
 \tkzDrawLines[add=0 and 1](Ja,Ma
                Jb,Mb Jc,Mc)
 \tkzDrawLines[add=1 and 1](A,B A,C B,C)
 \tkzDrawCircles[new](Ja,Ta Jb,Tb Jc,Tc)
 \tkzDrawPoints(B,C,A)
 \tkzDrawPoints[new](Mi)
 \tkzLabelPoints(Mi)
 \tkzLabelPoints[left](Mb)
 \tkzLabelPoints[new](Ma,Mc,Jb,Jc)
 \tkzLabelPoints[above left](Ja,Jc)
\end{tikzpicture}
```

### 11.1.12. Relation between gergonne, centroid and mittenpunkt

The Gergonne point Ge, triangle centroid G, and mittenpunkt M are collinear, with GeG/GM=2.




```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,2/2/B,8/0/C}
\tkzDefTriangleCenter[gergonne](A,B,C) \tkzGetPoint{Ge}
\tkzDefTriangleCenter[centroid](A,B,C)
\tkzGetPoint{G}
\tkzDefTriangleCenter[mittenpunkt](A,B,C)
\tkzGetPoint{M}
\tkzDrawLines[add=.25 and .25,teal](A,B A,C B,C)
\tkzDrawLines[add=.25 and .25,new](Ge,M)
\tkzDrawPoints(A,...,C)
\tkzDrawPoints[red,size=2](G,M,Ge)
\tkzLabelPoints(A,...,C,M,G,Ge)
\tkzMarkSegment[mark=s||](Ge,G)
\tkzMarkSegment[mark=s|](G,M)
\end{tikzpicture}
```

## 12. Definition of points by transformation

These transformations are:

- translation;
- homothety;

– orthogonal reflection or symmetry;

– central symmetry;

– orthogonal projection;

– rotation (degrees or radians);

– inversion with respect to a circle.

### 12.1. \tkzDefPointBy

The choice of transformations is made through the options. There are two macros, one for the transformation of a single point `\tkzDefPointBy` and the other for the transformation of a list of points `\tkzDefPointsBy`. By default the image of A is A′. For example, we'll write:

```
\tkzDefPointBy[translation= from A to A'](B)
```

The result is in **tkzPointResult**

`\tkzDefPointBy[⟨local options⟩](⟨pt⟩)`

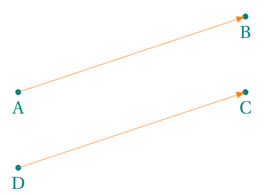
The argument is a simple existing point and its image is stored in **tkzPointResult**. If you want to keep this point then the macro `\tkzGetPoint{M}` allows you to assign the name `M` to the point.

| arguments | definition | examples |
|---|---|---|
| pt | existing point name | (A) |

| options | | examples |
|---|---|---|
| translation | = from #1 to #2 | [translation=from A to B](E) |
| homothety | = center #1 ratio #2 | [homothety=center A ratio .5](E) |
| reflection | = over #1--#2 | [reflection=over A--B](E) |
| symmetry | = center #1 | [symmetry=center A](E) |
| projection | = onto #1--#2 | [projection=onto A--B](E) |
| rotation | = center #1 angle #2 | [rotation=center O angle 30](E) |
| rotation in rad | = center #1 angle #2 | [rotation in rad=center O angle pi/3](E) |
| rotation with nodes | = center #1 from #2 to #3 | [center O from A to B](E) |
| inversion | = center #1 through #2 | [inversion =center O through A](E) |
| inversion negative | = center #1 through #2 | ... |

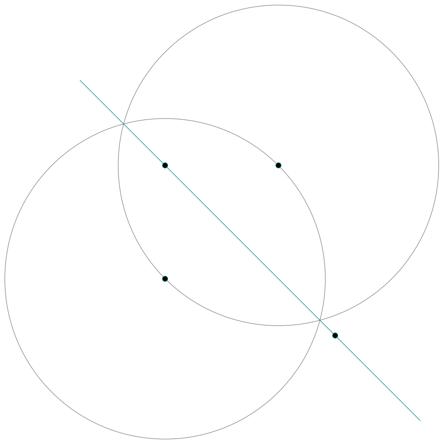
*The image is only defined and not drawn.*

#### 12.1.1. translation



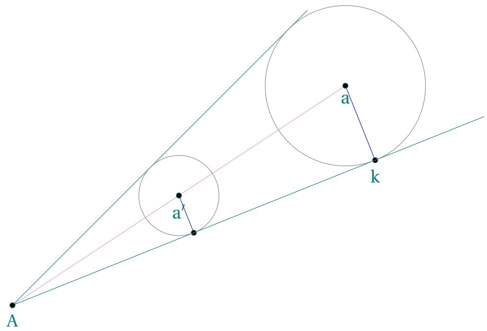

```
\begin{tikzpicture}[>=latex]
 \tkzDefPoints{0/0/A,3/1/B,3/0/C}
 \tkzDefPointBy[translation= from B to A](C)
 \tkzGetPoint{D}
 \tkzDrawPoints[teal](A,B,C,D)
 \tkzLabelPoints[color=teal](A,B,C,D)
 \tkzDrawSegments[orange,->](A,B D,C)
\end{tikzpicture}
```

### 12.1.2. reflection (orthogonal symmetry)



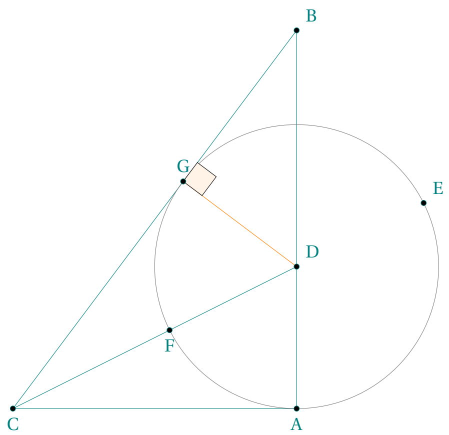
```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoints{-2/-2/A,-1/-1/C,-4/2/D,-4/0/O}
 \tkzDrawCircle(O,A)
 \tkzDefPointBy[reflection = over C--D](A)
 \tkzGetPoint{A'}
 \tkzDefPointBy[reflection = over C--D](O)
 \tkzGetPoint{O'}
 \tkzDrawCircle(O',A')
 \tkzDrawLine[add= .5 and .5](C,D)
 \tkzDrawPoints(C,D,O,O')
\end{tikzpicture}
```

### 12.1.3. homothety and projection



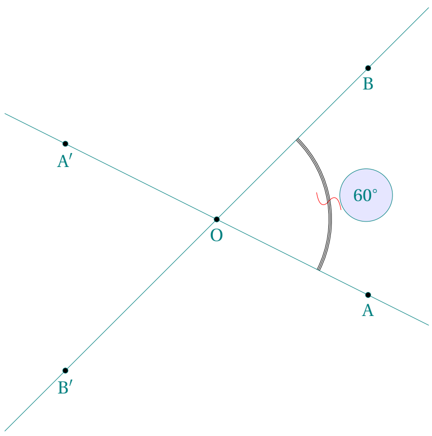

```
\begin{tikzpicture}
  \tkzDefPoints{0/1/A,5/3/B,3/4/C}
  \tkzDefLine[bisector](B,A,C) \tkzGetPoint{a}
  \tkzDrawLine[add=0 and 0,color=magenta!50 ](A,a)
  \tkzDefPointBy[homothety=center A ratio .5](a)
  \tkzGetPoint{a'}
  \tkzDefPointBy[projection = onto A--B](a')
  \tkzGetPoint{k'}
  \tkzDefPointBy[projection = onto A--B](a)
  \tkzGetPoint{k}
  \tkzDrawLines[add= 0 and .3](A,k A,C)
  \tkzDrawSegments[blue](a',k' a,k)
  \tkzDrawPoints(a,a',k,k',A)
  \tkzDrawCircles(a',k' a,k)
  \tkzLabelPoints(a,a',k,A)
\end{tikzpicture}
```

### 12.1.4. projection



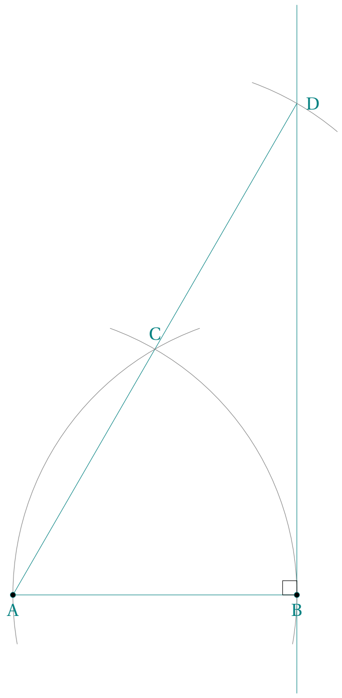

```
\begin{tikzpicture}[scale=1.25]
 \tkzDefPoints{0/0/A,0/4/B}
 \tkzDefTriangle[pythagore](B,A) \tkzGetPoint{C}
 \tkzDefLine[bisector](B,C,A) \tkzGetPoint{c}
 \tkzInterLL(C,c)(A,B)  \tkzGetPoint{D}
 \tkzDefPointBy[projection=onto B--C](D)
 \tkzGetPoint{G}
 \tkzInterLC(C,D)(D,A) \tkzGetPoints{E}{F}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawSegment(C,D)
 \tkzDrawCircle(D,A)
 \tkzDrawSegment[new](D,G)
 \tkzMarkRightAngle[fill=orange!10](D,G,B)
 \tkzDrawPoints(A,C,F) \tkzLabelPoints(A,C,F)
 \tkzDrawPoints(B,D,E,G)
 \tkzLabelPoints[above right](B,D,E)
  \tkzLabelPoints[above](G)
 \end{tikzpicture}
```

### 12.1.5. symmetry



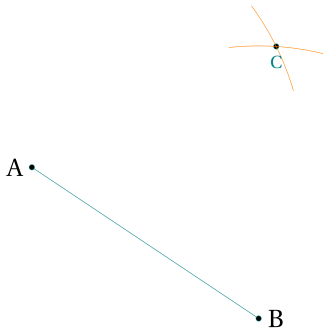

```
\begin{tikzpicture}[scale=1]
  \tkzDefPoints{2/-1/A,2/2/B,0/0/O}
  \tkzDefPointsBy[symmetry=center O](B,A){}
  \tkzDrawLine(A,A')
  \tkzDrawLine(B,B')
  \tkzMarkAngle[mark=s,arc=lll,
      size=1.5,mkcolor=red](A,O,B)
  \tkzLabelAngle[pos=2,circle,draw,
    fill=blue!10,font=\scriptsize](A,O,B){$60^{\circ}$}
  \tkzDrawPoints(A,B,O,A',B')
  \tkzLabelPoints(B,B')
  \tkzLabelPoints[below](A,O,A')
\end{tikzpicture}
```

### 12.1.6. rotation



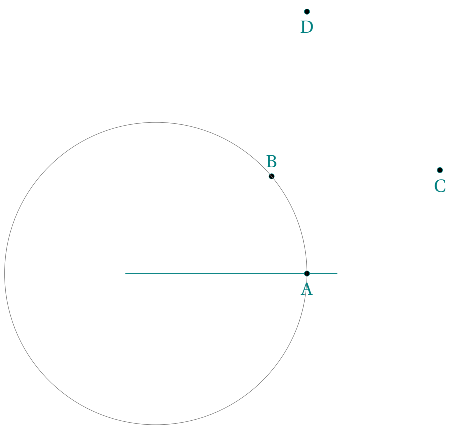

```
\begin{tikzpicture}[scale=0.75]
 \tkzDefPoints{0/0/A,5/0/B}
 \tkzDrawSegment(A,B)
 \tkzDefPointBy[rotation=center A angle 60](B)
 \tkzGetPoint{C}
 \tkzDefPointBy[symmetry=center C](A)
 \tkzGetPoint{D}
 \tkzDrawSegment(A,tkzPointResult)
 \tkzDrawLine(B,D)
 \tkzDrawArc(A,B)(C) \tkzDrawArc(B,C)(A)
 \tkzDrawArc(C,D)(D)
 \tkzMarkRightAngle(D,B,A)
 \tkzDrawPoints(A,B)
 \tkzLabelPoints(A,B)
 \tkzLabelPoints[above](C)
 \tkzLabelPoints[right](D)
\end{tikzpicture}
```

### 12.1.7. rotation in radian




```
\begin{tikzpicture}
  \tkzDefPoint["$A$" left](1,5){A}
  \tkzDefPoint["$B$" right](4,3){B}
  \tkzDefPointBy[rotation in rad= center A angle pi/3](B)
  \tkzGetPoint{C}
  \tkzDrawSegment(A,B)
  \tkzDrawPoints(A,B,C)
  \tkzCompass(A,C)
  \tkzCompass(B,C)
  \tkzLabelPoints(C)
\end{tikzpicture}
```

### 12.1.8. rotation with nodes



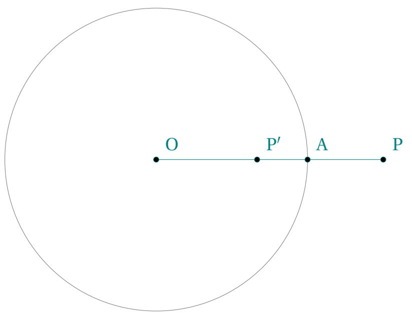

```
\begin{tikzpicture}
 \tkzDefPoint(0,0){O}
 \tkzDefPoint(0:2){A}
 \tkzDefPoint(40:2){B}
 \tkzDefPoint(20:4){C}
 \tkzDrawLine(O,A)
 \tkzDefPointBy[rotation with nodes%
            =center O from A to B](C)
 \tkzGetPoint{D}
\tkzDrawPoints(A,B,C,D)
\tkzDrawCircle(O,A)
\tkzLabelPoints(A,C,D)
\tkzLabelPoints[above](B)
\end{tikzpicture}
```

### 12.1.9. inversion

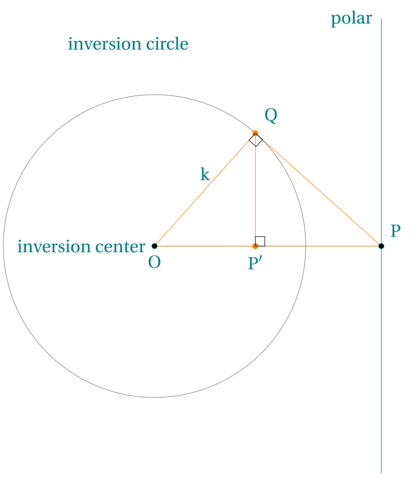
Inversion is the process of transforming points to a corresponding set of points known as their inverse points. Two points P and P′ are said to be inverses with respect to an inversion circle having inversion center O and inversion radius k if P′ is the perpendicular foot of the altitude of OQP, where Q is a point on the circle such that OQ is perpendicular to PQ.
The quantity $k^2$ is known as the circle power (Coxeter 1969, p. 81).
(https://mathworld.wolfram.com/Inversion.html)
Some propositions :

- The inverse of a circle (not through the center of inversion) is a circle.
- The inverse of a circle through the center of inversion is a line.
- The inverse of a line (not through the center of inversion) is a circle through the center of inversion.
- A circle orthogonal to the circle of inversion is its own inverse.
- A line through the center of inversion is its own inverse.
- Angles are preserved in inversion.

Explanation:
Directly (Center O power=$k^2 = OA^2 = OP \times OP'$)

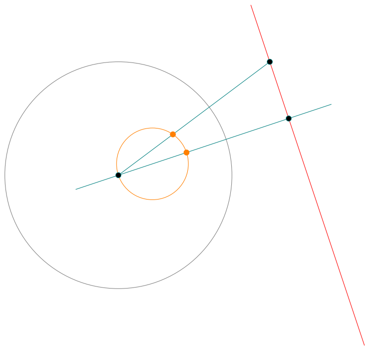



```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{4/0/A,6/0/P,0/0/O}
  \tkzDefPointBy[inversion = center O through A](P)
  \tkzGetPoint{P'}
  \tkzDrawSegments(O,P)
  \tkzDrawCircle(O,A)
  \tkzLabelPoints[above right,font=\scriptsize](O,A,P,P')
  \tkzDrawPoints(O,A,P,P')
\end{tikzpicture}
```



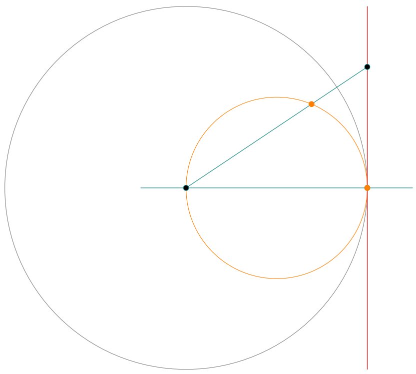

```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{4/0/A,6/0/P,0/0/O}
  \tkzDefLine[orthogonal=through P](O,P)
  \tkzGetPoint{L}
  \tkzDefLine[tangent from = P](O,A) \tkzGetPoints{R}{Q}
  \tkzDefPointBy[projection=onto O--A](Q) \tkzGetPoint{P'}
  \tkzDrawSegments(O,P O,A)
  \tkzDrawSegments[new](O,P O,Q P,Q Q,P')
  \tkzDrawCircle(O,A)
  \tkzDrawLines[add=1 and 0](P,L)
  \tkzLabelPoints[below,font=\scriptsize](O,P')
  \tkzLabelPoints[above right,font=\scriptsize](P,Q)
  \tkzDrawPoints(O,P) \tkzDrawPoints[new](Q,P')
  \tkzLabelSegment[above](O,Q){$k$}
  \tkzMarkRightAngles(A,P',Q P,Q,O)
  \tkzLabelCircle[above=.5cm,
      font=\scriptsize](O,A)(100){inversion circle}
  \tkzLabelPoint[left,font=\scriptsize](O){inversion center}
  \tkzLabelPoint[left,font=\scriptsize](L){polar}
\end{tikzpicture}
```

### 12.1.10. Inversion of lines ex 1



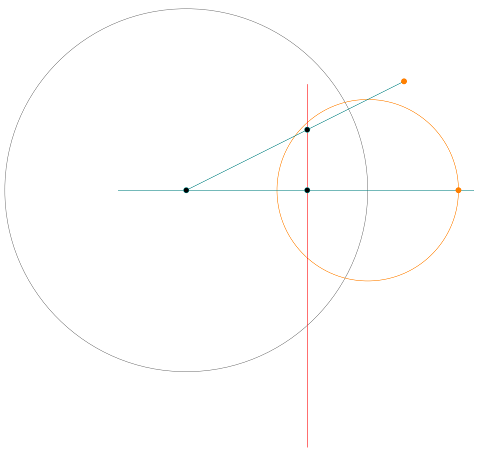
```
\begin{tikzpicture}[scale=.5]
\tkzDefPoints{0/0/O,3/0/I,4/3/P,6/-3/Q}
\tkzDrawCircle(O,I)
\tkzDefPointBy[projection= onto P--Q](O) \tkzGetPoint{A}
\tkzDefPointBy[inversion = center O through I](A)
\tkzGetPoint{A'}
\tkzDefPointBy[inversion = center O through I](P)
\tkzGetPoint{P'}
\tkzDefCircle[diameter](O,A')\tkzGetPoint{o}
\tkzDrawCircle[new](o,A')
\tkzDrawLines[add=.25 and .25,red](P,Q)
\tkzDrawLines[add=.25 and .25](O,A)
\tkzDrawSegments(O,P)
\tkzDrawPoints(A,P,O) \tkzDrawPoints[new](A',P')
\end{tikzpicture}
```

### 12.1.11. inversion of lines ex 2



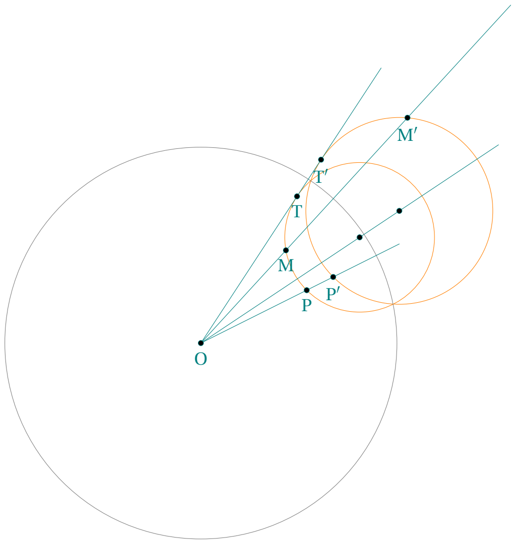
```
\begin{tikzpicture}[scale=.8]
\tkzDefPoints{0/0/O,3/0/I,3/2/P,3/-2/Q}
\tkzDrawCircle(O,I)
\tkzDefPointBy[projection= onto P--Q](O) \tkzGetPoint{A}
\tkzDefPointBy[inversion = center O through I](A)
\tkzGetPoint{A'}
\tkzDefPointBy[inversion = center O through I](P)
\tkzGetPoint{P'}
\tkzDefCircle[diameter](O,A')\tkzGetPoint{o}
\tkzDrawCircle[new](o,A')
\tkzDrawLines[add=.25 and .25,red](P,Q)
\tkzDrawLines[add=.25 and .25](O,A)
\tkzDrawSegments(O,P)
\tkzDrawPoints(A,P,O) \tkzDrawPoints[new](A',P')
\end{tikzpicture}
```

### 12.1.12. inversion of lines ex 3



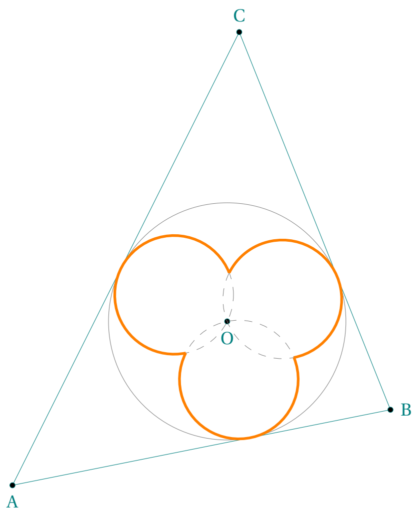
```
\begin{tikzpicture}[scale=.8]
\tkzDefPoints{0/0/O,3/0/I,2/1/P,2/-2/Q}
\tkzDrawCircle(O,I)
\tkzDefPointBy[projection= onto P--Q](O) \tkzGetPoint{A}
\tkzDefPointBy[inversion = center O through I](A)
\tkzGetPoint{A'}
\tkzDefPointBy[inversion = center O through I](P)
\tkzGetPoint{P'}
\tkzDefCircle[diameter](O,A')
\tkzDrawCircle[new](I,A')
\tkzDrawLines[add=.25 and .75,red](P,Q)
\tkzDrawLines[add=.25 and .25](O,A')
\tkzDrawSegments(O,P')
\tkzDrawPoints(A,P,O) \tkzDrawPoints[new](A',P')
\end{tikzpicture}
```

### 12.1.13. inversion of circle and homothety




```
\begin{tikzpicture}[scale=.7]
\tkzDefPoints{0/0/O,3/2/A,2/1/P}
\tkzDefLine[tangent from = O](A,P) \tkzGetPoints{T}{X}
\tkzDefPointsBy[homothety = center O%
                ratio 1.25](A,P,T){}
\tkzInterCC(A,P)(A',P') \tkzGetPoints{C}{D}
\tkzCalcLength(A,P)
\tkzGetLength{rAP}
\tkzDefPointOnCircle[R=center A angle 190 radius \rAP]
\tkzGetPoint{M}
\tkzDefPointBy[inversion = center O through C](M)
\tkzGetPoint{M'}
\tkzDrawCircles[new](A,P A',P')
\tkzDrawCircle(O,C)
\tkzDrawLines[add=0 and .5](O,T' O,A' O,M' O,P')
\tkzDrawPoints(A,A',P,P',O,T,T',M,M')
\tkzLabelPoints(O,T,T',M,M')
\tkzLabelPoints[below](P,P')
\end{tikzpicture}
```

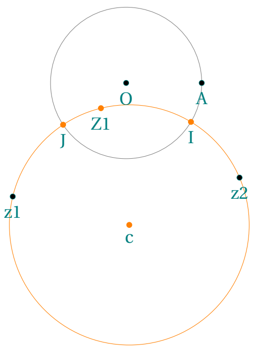
### 12.1.14. inversion of Triangle with respect to the Incircle




```
\begin{tikzpicture}[scale=1]
\tkzDefPoints{0/0/A,5/1/B,3/6/C}
\tkzDefTriangleCenter[in](A,B,C) \tkzGetPoint{O}
\tkzDefPointBy[projection= onto A--C](O) \tkzGetPoint{b}
\tkzDefPointBy[projection= onto A--C](O) \tkzGetPoint{b}
\tkzDefPointBy[projection= onto B--C](O) \tkzGetPoint{a}
\tkzDefPointBy[projection= onto A--B](O) \tkzGetPoint{c}
\tkzDefPointsBy[inversion = center O through b](a,b,c)%
                                          {Ia,Ib,Ic}
\tkzDefMidPoint(O,Ia) \tkzGetPoint{Ja}
\tkzDefMidPoint(O,Ib) \tkzGetPoint{Jb}
\tkzDefMidPoint(O,Ic) \tkzGetPoint{Jc}
\tkzInterCC(Ja,O)(Jb,O) \tkzGetPoints{O}{x}
\tkzInterCC(Ja,O)(Jc,O) \tkzGetPoints{y}{O}
\tkzInterCC(Jb,O)(Jc,O) \tkzGetPoints{O}{z}
\tkzDrawPolygon(A,B,C)
\tkzDrawCircle(O,b)\tkzDrawPoints(A,B,C,O)
\tkzDrawCircles[dashed,gray](Ja,y Jb,x Jc,z)
\tkzDrawArc[line width=1pt,orange,delta=0](Jb,x)(z)
\tkzDrawArc[line width=1pt,orange,delta=0](Jc,z)(y)
\tkzDrawArc[line width=1pt,orange,delta=0](Ja,y)(x)
\tkzLabelPoint[below](A){$A$}\tkzLabelPoint[above](C){$C$}
\tkzLabelPoint[right](B){$B$}\tkzLabelPoint[below](O){$O$}
\end{tikzpicture}
```

### 12.1.15. inversion: orthogonal circle with inversion circle

The inversion circle itself, circles orthogonal to it, and lines through the inversion center are invariant under inversion. If the circle meets the reference circle, these invariant points of intersection are also on the inverse circle. See I and J in the next figure.

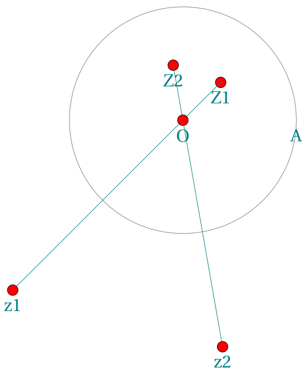



```
\begin{tikzpicture}[scale=1]
\tkzDefPoint(0,0){O}\tkzDefPoint(1,0){A}
\tkzDefPoint(-1.5,-1.5){z1}
\tkzDefPoint(1.5,-1.25){z2}
\tkzDefCircle[orthogonal through=z1 and z2](O,A)
\tkzGetPoint{c}
\tkzDrawCircle[new](c,z1)
\tkzDefPointBy[inversion =  center O through A](z1)
\tkzGetPoint{Z1}
\tkzInterCC(O,A)(c,z1) \tkzGetPoints{I}{J}
\tkzDefPointBy[inversion =  center O through A](I)
\tkzGetPoint{I'}
\tkzDrawCircle(O,A)
\tkzDrawPoints(O,A,z1,z2)
\tkzDrawPoints[new](c,Z1,I,J)
\tkzLabelPoints(O,A,z1,z2,c,Z1,I,J)
\end{tikzpicture}
```

For a more complex example see **Pappus** 47.25

### 12.1.16. inversion negative

It's an inversion followed by a symmetry of center O




```
\begin{tikzpicture}[scale=1.5]
  \tkzDefPoints{1/0/A,0/0/O}
  \tkzDefPoint(-1.5,-1.5){z1}
  \tkzDefPoint(0.35,-2){z2}
  \tkzDefPointBy[inversion negative = center O through A](z1)
  \tkzGetPoint{Z1}
  \tkzDefPointBy[inversion negative = center O through A](z2)
  \tkzGetPoint{Z2}
  \tkzDrawCircle(O,A)
  \tkzDrawPoints[color=black, fill=red,size=4](Z1,Z2)
  \tkzDrawSegments(z1,Z1 z2,Z2)
  \tkzDrawPoints[color=black, fill=red,size=4](O,z1,z2)
  \tkzLabelPoints[font=\scriptsize](O,A,z1,z2,Z1,Z2)
\end{tikzpicture}
```

### 12.2. Transformation of multiple points; \tkzDefPointsBy

Variant of the previous macro for defining multiple images. You must give the names of the images as arguments, or indicate that the names of the images are formed from the names of the antecedents, leaving the argument empty.

```
\tkzDefPointsBy[translation= from A to A'](B,C){}
```

The images are B′ and C′.

```
\tkzDefPointsBy[translation= from A to A'](B,C){D,E}
```

The images are D and E.

```
\tkzDefPointsBy[translation= from A to A'](B)
```

The image is B′.

**\tkzDefPointsBy[⟨local options⟩](⟨list of points⟩){⟨list of points⟩}**

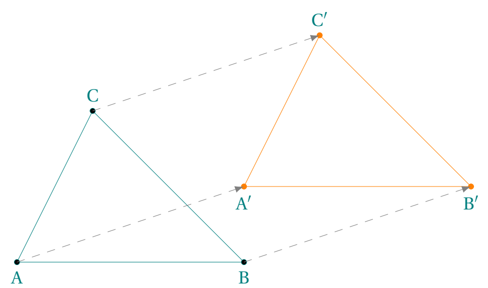
| arguments | examples |
|---|---|
| (⟨list of points⟩){⟨list of pts⟩} | (A,B){E,F} E,F images of A, B |

If the list of images is empty then the name of the image is the name of the antecedent to which " ' " is added.

| options | examples |
|---|---|
| translation = from #1 to #2 | [translation=from A to B](E){} |
| homothety = center #1 ratio #2 | [homothety=center A ratio .5](E){F} |
| reflection = over #1--#2 | [reflection=over A--B](E){F} |
| symmetry = center #1 | [symmetry=center A](E){F} |
| projection = onto #1--#2 | [projection=onto A--B](E){F} |
| rotation = center #1 angle #2 | [rotation=center angle 30](E){F} |
| rotation in rad = center #1 angle #2 | for instance angle pi/3 |
| rotation with nodes = center #1 from #2 to #3 | [center O from A to B](E){F} |
| inversion = center #1 through #2 | [inversion = center O through A](E){F} |
| inversion negative = center #1 through #2 | ... |

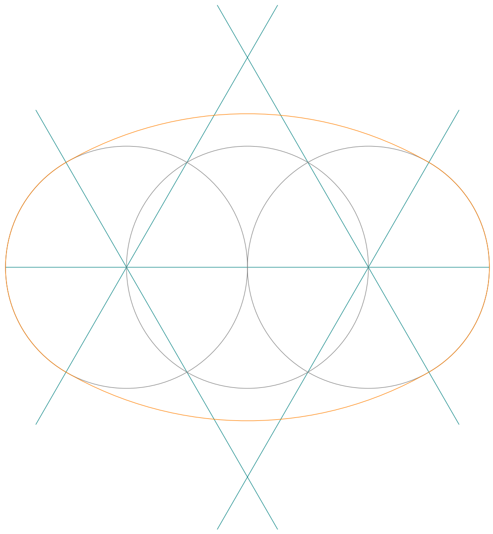
The points are only defined and not drawn.

#### 12.2.1. translation of multiple points




```
\begin{tikzpicture}[>=latex]
 \tkzDefPoints{0/0/A,3/0/B,3/1/A',1/2/C}
 \tkzDefPointsBy[translation= from A to A'](B,C){}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPolygon[new](A',B',C')
 \tkzDrawPoints(A,B,C)
 \tkzDrawPoints[new](A',B',C')
 \tkzLabelPoints(A,B,A',B')
 \tkzLabelPoints[above](C,C')
 \tkzDrawSegments[color = gray,->,
              style=dashed](A,A' B,B' C,C')
\end{tikzpicture}
```

#### 12.2.2. symmetry of multiple points: an oval



```
\begin{tikzpicture}[scale=0.4]
  \tkzDefPoint(-4,0){I}
  \tkzDefPoint(4,0){J}
  \tkzDefPoint(0,0){O}
  \tkzInterCC(J,O)(O,J) \tkzGetPoints{L}{H}
  \tkzInterCC(I,O)(O,I) \tkzGetPoints{K}{G}
  \tkzInterLL(I,K)(J,H) \tkzGetPoint{M}
  \tkzInterLL(I,G)(J,L) \tkzGetPoint{N}
  \tkzDefPointsBy[symmetry=center J](L,H){D,E}
  \tkzDefPointsBy[symmetry=center I](G,K){C,F}
  \begin{scope}[line style/.style = {very thin,teal}]
    \tkzDrawLines[add=1.5 and 1.5](I,K I,G J,H J,L)
    \tkzDrawLines[add=.5 and .5](I,J)
    \tkzDrawCircles(O,I I,O J,O)
    \tkzDrawArc[delta=0,orange](N,D)(C)
    \tkzDrawArc[delta=0,orange](M,F)(E)
    \tkzDrawArc[delta=0,orange](J,E)(D)
    \tkzDrawArc[delta=0,orange](I,C)(F)
  \end{scope}
\end{tikzpicture}
```

## 13. Defining points using a vector

### 13.1. \tkzDefPointWith

There are several possibilities to create points that meet certain vector conditions. This can be done with `\tkzDefPointWith`. The general principle is as follows, two points are passed as arguments, i.e. a vector. The different options allow to obtain a new point forming with the first point (with some exceptions) a collinear vector or a vector orthogonal to the first vector. Then the length is either proportional to that of the first one, or proportional to the unit. Since this point is only used temporarily, it does not have to be named immediately. The result is in `tkzPointResult`. The macro `\tkzGetPoint` allows you to retrieve the point and name it differently. There are options to define the distance between the given point and the obtained point. In the general case this distance is the distance between the 2 points given as arguments if the option is of the "normed" type then the distance between the given point and the obtained point is 1 cm. Then the K option allows to obtain multiples.

`\tkzDefPointWith(⟨pt1,pt2⟩)`

It is in fact the definition of a point meeting vectorial conditions.

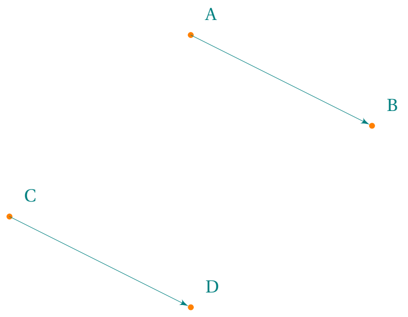
| arguments | definition | explanation |
|---|---|---|
| (pt1,pt2) | point couple | the result is a point in **tkzPointResult** |

In what follows, it is assumed that the point is recovered by **\tkzGetPoint{C}**

| options | example | explanation |
|---|---|---|
| orthogonal | [orthogonal](A,B) | $AC = AB$ and $\overrightarrow{AC} \perp \overrightarrow{AB}$ |
| orthogonal normed | [orthogonal normed](A,B) | $AC = 1$ and $\overrightarrow{AC} \perp \overrightarrow{AB}$ |
| linear | [linear](A,B) | $\overrightarrow{AC} = K \times \overrightarrow{AB}$ |
| linear normed | [linear normed](A,B) | $AC = K$ and $\overrightarrow{AC} = k \times \overrightarrow{AB}$ |
| colinear= at #1 | [colinear= at C](A,B) | $\overrightarrow{CD} = \overrightarrow{AB}$ |
| colinear normed= at #1 | [colinear normed= at C](A,B) | $\overrightarrow{CD} = \overrightarrow{AB}$ |
| K | [linear](A,B),K=2 | $\overrightarrow{AC} = 2 \times \overrightarrow{AB}$ |

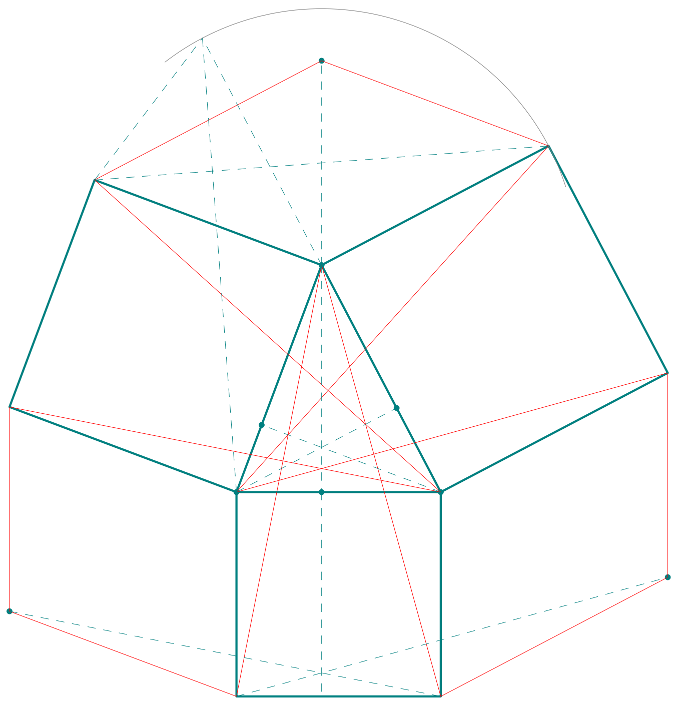
### 13.1.1. Option colinear at, simple example

$(\overrightarrow{AB} = \overrightarrow{CD})$




```
\begin{tikzpicture}[scale=1.2,
   vect/.style={->,shorten >=1pt,>=latex'}]
  \tkzDefPoint(2,3){A}   \tkzDefPoint(4,2){B}
  \tkzDefPoint(0,1){C}
  \tkzDefPointWith[colinear=at C](A,B)
  \tkzGetPoint{D}
  \tkzDrawPoints[new](A,B,C,D)
  \tkzLabelPoints[above right=3pt](A,B,C,D)
  \tkzDrawSegments[vect](A,B C,D)
\end{tikzpicture}
```

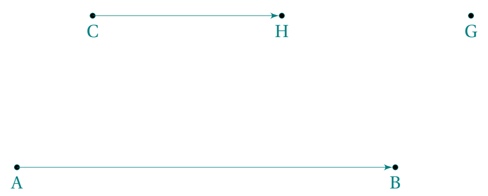
### 13.1.2. Option colinear at, complex example



```
\begin{tikzpicture}[scale=.75]
\tkzDefPoints{0/0/B,3.6/0/C,1.5/4/A}
\tkzDefSpcTriangle[ortho](A,B,C){Ha,Hb,Hc}
\tkzDefTriangleCenter[ortho](A,B,C) \tkzGetPoint{H}
\tkzDefSquare(A,C) \tkzGetPoints{R}{S}
\tkzDefSquare(B,A) \tkzGetPoints{M}{N}
\tkzDefSquare(C,B) \tkzGetPoints{P}{Q}
\tkzDefPointWith[colinear= at M](A,S) \tkzGetPoint{A'}
\tkzDefPointWith[colinear= at P](B,N) \tkzGetPoint{B'}
\tkzDefPointWith[colinear= at Q](C,R) \tkzGetPoint{C'}
\tkzDefPointBy[projection=onto P--Q](Ha) \tkzGetPoint{Pa}
\tkzDrawPolygon[teal,thick](A,C,R,S)\tkzDrawPolygon[teal,thick](A,B,N,M)
\tkzDrawPolygon[teal,thick](C,B,P,Q)
\tkzDrawPoints[teal,size=2](A,B,C,Ha,Hb,Hc,A',B',C')
\tkzDrawSegments[ultra thin,red](M,A' A',S P,B' B',N Q,C' C',R B,S C,M C,N B,R A,P A,Q)
\tkzDrawSegments[ultra thin,teal, dashed](A,Ha B,Hb C,Hc)
\tkzDefPointBy[rotation=center A angle 90](S) \tkzGetPoint{S'}
\tkzDrawSegments[ultra thin,teal,dashed](B,S' A,S' A,A' M,S' B',Q P,C' M,S Ha,Pa)
\tkzDrawArc(A,S)(S')
\end{tikzpicture}
```

### 13.1.3. Option `colinear at`

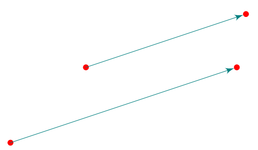
How to use K




```
\begin{tikzpicture}[vect/.style={->,
               shorten >=1pt,>=latex'}]
  \tkzDefPoints{0/0/A,5/0/B,1/2/C}
  \tkzDefPointWith[colinear=at C](A,B)
  \tkzGetPoint{G}
  \tkzDefPointWith[colinear=at C, K=0.5](A,B)
  \tkzGetPoint{H}
  \tkzLabelPoints(A,B,C,G,H)
  \tkzDrawPoints(A,B,C,G,H)
  \tkzDrawSegments[vect](A,B C,H)
\end{tikzpicture}
```

### 13.1.4. Option `colinear at`

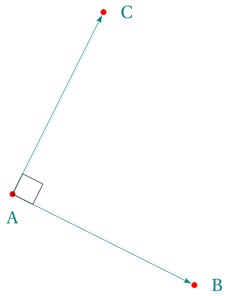
With $K = \frac{\sqrt{2}}{2}$



```
\begin{tikzpicture}[vect/.style={->,
            shorten >=1pt,>=latex'}]
 \tkzDefPoints{1/1/A,4/2/B,2/2/C}
 \tkzDefPointWith[colinear=at C,K=sqrt(2)/2](A,B)
 \tkzGetPoint{D}
 \tkzDrawPoints[color=red](A,B,C,D)
 \tkzDrawSegments[vect](A,B C,D)
\end{tikzpicture}
```

### 13.1.5. Option `orthogonal`

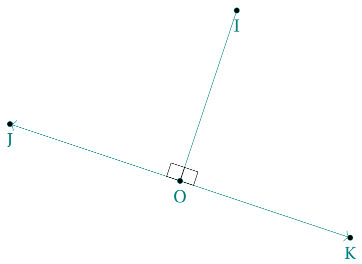
AB=AC since K = 1.




```
\begin{tikzpicture}[scale=1.2,
  vect/.style={->,shorten >=1pt,>=latex'}]
  \tkzDefPoints{2/3/A,4/2/B}
   \tkzDefPointWith[orthogonal,K=1](A,B)
     \tkzGetPoint{C}
   \tkzDrawPoints[color=red](A,B,C)
   \tkzLabelPoints[right=3pt](B,C)
   \tkzLabelPoints[below=3pt](A)
   \tkzDrawSegments[vect](A,B A,C)
   \tkzMarkRightAngle(B,A,C)
\end{tikzpicture}
```

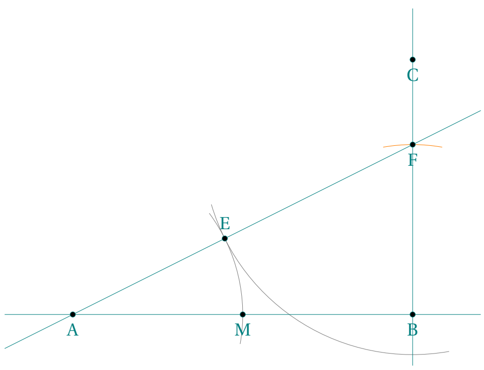
### 13.1.6. Option **orthogonal**

With K = −1 OK=OI since |K| = 1 then OI=OJ=OK.



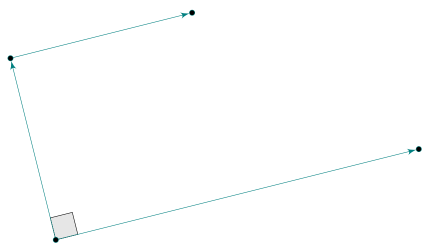

```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{1/2/O,2/5/I}
  \tkzDefPointWith[orthogonal](O,I)
  \tkzGetPoint{J}
  \tkzDefPointWith[orthogonal,K=-1](O,I)
  \tkzGetPoint{K}
  \tkzDrawSegment(O,I)
  \tkzDrawSegments[->](O,J O,K)
  \tkzMarkRightAngles(I,O,J I,O,K)
  \tkzDrawPoints(O,I,J,K)
  \tkzLabelPoints(O,I,J,K)
\end{tikzpicture}
```

### 13.1.7. Option **orthogonal** more complicated example




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/A,6/0/B}
  \tkzDefMidPoint(A,B)
    \tkzGetPoint{I}
  \tkzDefPointWith[orthogonal,K=-.75](B,A)
  \tkzGetPoint{C}
  \tkzInterLC(B,C)(B,I)
     \tkzGetPoints{D}{F}
  \tkzDuplicateSegment(B,F)(A,F)
  \tkzGetPoint{E}
  \tkzDrawArc[delta=10](F,E)(B)
  \tkzInterLC(A,B)(A,E)
    \tkzGetPoints{N}{M}
  \tkzDrawArc[delta=10](A,M)(E)
  \tkzDrawLines(A,B B,C A,F)
  \tkzCompass(B,F)
  \tkzDrawPoints(A,B,C,F,M,E)
  \tkzLabelPoints(A,B,C,F,M)
  \tkzLabelPoints[above](E)
\end{tikzpicture}
```

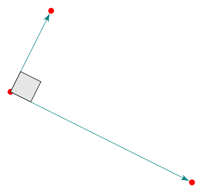
### 13.1.8. Options colinear and orthogonal



```
\begin{tikzpicture}[scale=1.2,
  vect/.style={->,shorten >=1pt,>=latex'}]
  \tkzDefPoints{2/1/A,6/2/B}
  \tkzDefPointWith[orthogonal,K=.5](A,B)
  \tkzGetPoint{C}
  \tkzDefPointWith[colinear=at C,K=.5](A,B)
  \tkzGetPoint{D}
  \tkzMarkRightAngle[fill=gray!20](B,A,C)
  \tkzDrawSegments[vect](A,B A,C C,D)
  \tkzDrawPoints(A,...,D)
\end{tikzpicture}
```

### 13.1.9. Option orthogonal normed

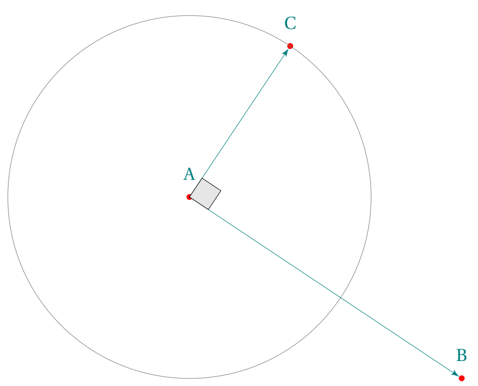
K = 1 AC = 1.



```
\begin{tikzpicture}[scale=1.2,
  vect/.style={->,shorten >=1pt,>=latex'}]
  \tkzDefPoints{2/3/A,4/2/B}
  \tkzDefPointWith[orthogonal normed](A,B)
  \tkzGetPoint{C}
  \tkzDrawPoints[color=red](A,B,C)
  \tkzDrawSegments[vect](A,B A,C)
  \tkzMarkRightAngle[fill=gray!20](B,A,C)
\end{tikzpicture}
```

### 13.1.10. Option orthogonal normed and K=2

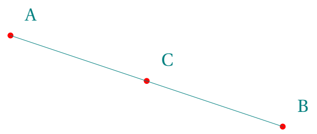
K = 2 therefore AC = 2.




```
\begin{tikzpicture}[scale=1.2,
   vect/.style={->,shorten >=1pt,>=latex'}]
  \tkzDefPoints{2/3/A,5/1/B}
  \tkzDefPointWith[orthogonal normed,K=2](A,B)
  \tkzGetPoint{C}
  \tkzDrawPoints[color=red](A,B,C)
  \tkzDefCircle[R](A,2) \tkzGetPoint{a}
  \tkzDrawCircle(A,a)
  \tkzDrawSegments[vect](A,B A,C)
  \tkzMarkRightAngle[fill=gray!20](B,A,C)
  \tkzLabelPoints[above=3pt](A,B,C)
\end{tikzpicture}
```

### 13.1.11. Option linear

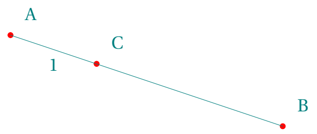
Here K = 0.5.
This amounts to applying a homothety or a multiplication of a vector by a real. Here is the middle of [AB].




```
\begin{tikzpicture}[scale=1.2]
  \tkzDefPoints{1/3/A,4/2/B}
  \tkzDefPointWith[linear,K=0.5](A,B)
  \tkzGetPoint{C}
  \tkzDrawPoints[color=red](A,B,C)
  \tkzDrawSegment(A,B)
  \tkzLabelPoints[above right=3pt](A,B,C)
\end{tikzpicture}
```

#### 13.1.12. Option linear normed

In the following example AC = 1 and C belongs to (AB).




```
\begin{tikzpicture}[scale=1.2]
 \tkzDefPoints{1/3/A,4/2/B}
 \tkzDefPointWith[linear normed](A,B)
 \tkzGetPoint{C}
 \tkzDrawPoints[color=red](A,B,C)
 \tkzDrawSegment(A,B)
 \tkzLabelSegment(A,C){$1$}
 \tkzLabelPoints[above right=3pt](A,B,C)
\end{tikzpicture}
```

### 13.2. \tkzGetVectxy

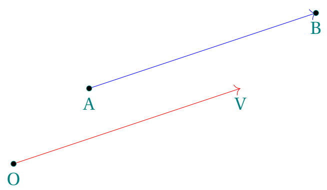
Retrieving the coordinates of a vector.

**\tkzGetVectxy(⟨A,B⟩){⟨text⟩}**

Allows to obtain the coordinates of a vector.

| arguments | example | explanation |
|---|---|---|
| (point){name of macro} | \tkzGetVectxy(A,B){V} | \Vx,\Vy: coordinates of $\overrightarrow{AB}$ |

#### 13.2.1. Coordinate transfer with \tkzGetVectxy




```
\begin{tikzpicture}
 \tkzDefPoints{0/0/O,1/1/A,4/2/B}
 \tkzGetVectxy(A,B){v}
 \tkzDefPoint(\vx,\vy){V}
 \tkzDrawSegment[->,color=red](O,V)
 \tkzDrawSegment[->,color=blue](A,B)
 \tkzDrawPoints(A,B,O)
 \tkzLabelPoints(A,B,O,V)
\end{tikzpicture}
```

## 14. Straight lines

It is of course essential to draw straight lines, but before this can be done, it is necessary to be able to define certain particular lines such as mediators, bisectors, parallels or even perpendiculars. The principle is to determine two points on the straight line.

### 14.1. Definition of straight lines

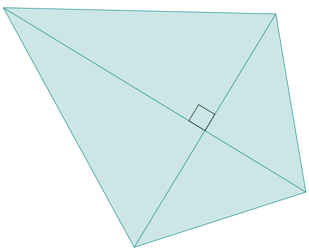
**\tkzDefLine[⟨local options⟩](⟨pt1,pt2⟩) or (⟨pt1,pt2,pt3⟩)**

The argument is a list of two or three points. Depending on the case, the macro defines one or two points necessary to obtain the line sought. Either the macro **\tkzGetPoint** or the macro **\tkzGetPoints** must be used. I used the term "mediator" to designate the perpendicular bisector line at the middle of a line segment.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | [mediator](⟨A,B⟩) | mediator of the segment [A,B] |
| (⟨pt1,pt2,pt3⟩) | [bisector](⟨A,B,C⟩) | bisector of $\widehat{ABC}$ |
| (⟨pt1,pt2,pt3⟩) | [altitude](⟨A,B,C⟩) | altitude from B |
| (⟨pt1⟩) | [tangent at=A](⟨O⟩) | tangent at A on the circle center O |
| (⟨pt1,pt2⟩) | [tangent from=A](⟨O,B⟩) | circle center O through B |

| options | default | definition |
|---|---|---|
| mediator | | perpendicular bisector of a line segment |
| perpendicular=through... | mediator | perpendicular to a line passing through a point |
| orthogonal=through... | mediator | see above |
| parallel=through... | mediator | parallel to a line passing through a point |
| bisector | mediator | bisector of an angle defined by three points |
| bisector out | mediator | exterior angle bisector |
| symmedian | mediator | symmedian from a vertex |
| altitude | mediator | altitude from avertex |
| euler | mediator | euler line of a triangle |
| tangent at | mediator | tangent at a point of a circle |
| tangent from | mediator | tangent from an exterior point |
| K | 1 | coefficient for the perpendicular line |
| normed | false | normalizes the created segment |

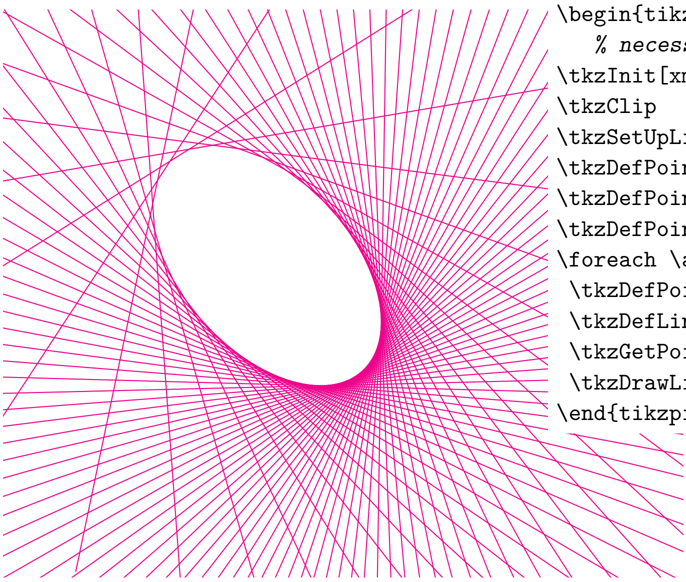
### 14.1.1. With mediator



```
\begin{tikzpicture}[rotate=25]
 \tkzDefPoints{-2/0/A,1/2/B}
 \tkzDefLine[mediator](A,B)          \tkzGetPoints{C}{D}
 \tkzDefPointWith[linear,K=.75](C,D) \tkzGetPoint{D}
 \tkzDefMidPoint(A,B)                \tkzGetPoint{I}
 \tkzFillPolygon[color=teal!20](A,C,B,D)
 \tkzDrawSegments(A,B C,D)
 \tkzMarkRightAngle(B,I,C)
 \tkzDrawSegments(D,B D,A)
 \tkzDrawSegments(C,B C,A)
\end{tikzpicture}
```

### 14.1.2. An envelope with option mediator

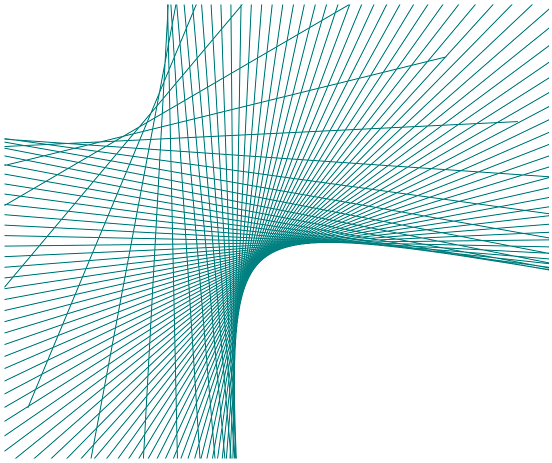
Based on a figure from O. Reboux with pst-eucl by D Rodriguez.



```
\begin{tikzpicture}[scale=.75]
   % necessary
\tkzInit[xmin=-6,ymin=-4,xmax=6,ymax=6]
\tkzClip
\tkzSetUpLine[thin,color=magenta]
\tkzDefPoint(0,0){O}
\tkzDefPoint(132:4){A}
\tkzDefPoint(5,0){B}
\foreach \ang in {5,10,...,360}{%
 \tkzDefPoint(\ang:5){M}
 \tkzDefLine[mediator](A,M)
 \tkzGetPoints{x}{y}
 \tkzDrawLine[add= 3 and 3](x,y)}
\end{tikzpicture}
```

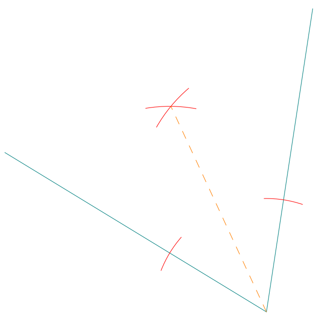
### 14.1.3. A parabola with option mediator

Based on a figure from O. Reboux with pst-eucl by D Rodriguez. It is not necessary to name the two points that define the mediator.



```
\begin{tikzpicture}[scale=.6]
\tkzInit[xmin=-6,ymin=-4,xmax=6,ymax=6]
\tkzClip
\tkzSetUpLine[thin,color=teal]
\tkzDefPoint(0,0){O}
\tkzDefPoint(132:5){A}
\tkzDefPoint(4,0){B}
\foreach \ang in {5,10,...,360}{%
 \tkzDefPoint(\ang:4){M}
 \tkzDefLine[mediator](A,M)
 \tkzGetPoints{x}{y}
 \tkzDrawLine[add= 3 and 3](x,y)}
\end{tikzpicture}
```

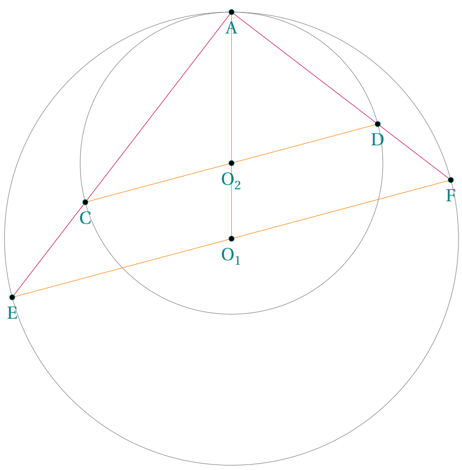
### 14.1.4. With options bisector and normed



```
\begin{tikzpicture}[rotate=25,scale=.75]
 \tkzDefPoints{0/0/C, 2/-3/A, 4/0/B}
 \tkzDefLine[bisector,normed](B,A,C) \tkzGetPoint{a}
 \tkzDrawLines[add= 0 and .5](A,B A,C)
 \tkzShowLine[bisector,gap=4,size=2,color=red](B,A,C)
 \tkzDrawLines[new,dashed,add= 0 and 3](A,a)
\end{tikzpicture}
```

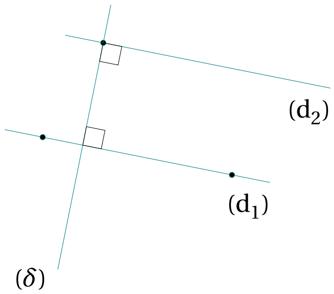
### 14.1.5. With option parallel=through

Archimedes' Book of Lemmas proposition 1



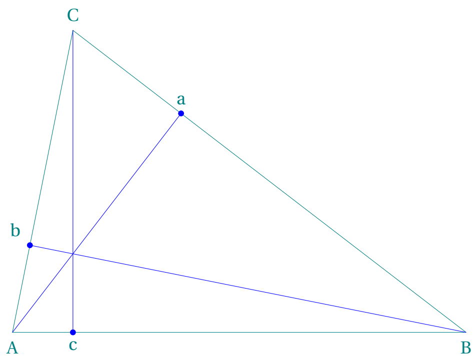

```
\begin{tikzpicture}
  \tkzDefPoints{0/0/O_1,0/1/O_2,0/3/A}
  \tkzDefPoint(15:3){F}
  \tkzDefPointBy[symmetry=center O_1](F)
  \tkzGetPoint{E}
  \tkzDefLine[parallel=through O_2](E,F)
  \tkzGetPoint{x}
  \tkzInterLC(x,O_2)(O_2,A) \tkzGetPoints{D}{C}
  \tkzDrawCircles(O_1,A O_2,A)
  \tkzDrawSegments[new](O_1,A E,F C,D)
  \tkzDrawSegments[purple](A,E A,F)
  \tkzDrawPoints(A,O_1,O_2,E,F,C,D)
  \tkzLabelPoints(A,O_1,O_2,E,F,C,D)
\end{tikzpicture}
```

### 14.1.6. With option orthogonal and parallel



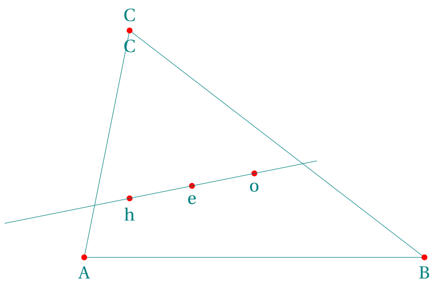

```
\begin{tikzpicture}
   \tkzDefPoints{-1.5/-0.25/A,1/-0.75/B,-0.7/1/C}
   \tkzDrawLine(A,B)
   \tkzLabelLine[pos=1.25,below left](A,B){$(d_1)$}
   \tkzDrawPoints(A,B,C)
   \tkzDefLine[orthogonal=through C](B,A) \tkzGetPoint{c}
   \tkzDrawLine(C,c)
   \tkzLabelLine[pos=1.25,left](C,c){$(\delta)$}
   \tkzInterLL(A,B)(C,c) \tkzGetPoint{I}
   \tkzMarkRightAngle(C,I,B)
   \tkzDefLine[parallel=through C](A,B) \tkzGetPoint{c'}
   \tkzDrawLine(C,c')
   \tkzLabelLine[pos=1.25,below left](C,c'){$(d_2)$}
   \tkzMarkRightAngle(I,C,c')
\end{tikzpicture}
```

### 14.1.7. With option altitude



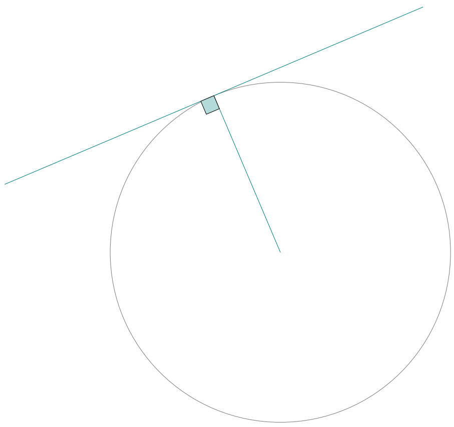

```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
\tkzDefLine[altitude](A,B,C)      \tkzGetPoint{b}
\tkzDefLine[altitude](B,C,A)      \tkzGetPoint{c}
\tkzDefLine[altitude](B,A,C)      \tkzGetPoint{a}
\tkzDrawPolygon(A,B,C)
\tkzDrawPoints[blue](a,b,c)
\tkzDrawSegments[blue](A,a B,b C,c)
\tkzLabelPoints(A,B,c)
\tkzLabelPoints[above](C,a)
\tkzLabelPoints[above left](b)
\end{tikzpicture}
```

### 14.1.8. With option euler




```
\begin{tikzpicture}[scale=.75]
\tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
\tkzDefLine[euler](A,B,C)
\tkzGetPoints{h}{e}
\tkzDefTriangleCenter[circum](A,B,C)
\tkzGetPoint{o}
\tkzDrawPolygon[teal](A,B,C)
\tkzDrawPoints[red](A,B,C,h,e,o)
\tkzDrawLine[add= 2 and 2](h,e)
\tkzLabelPoints(A,B,C,h,e,o)
\tkzLabelPoints[above](C)
\end{tikzpicture}
```

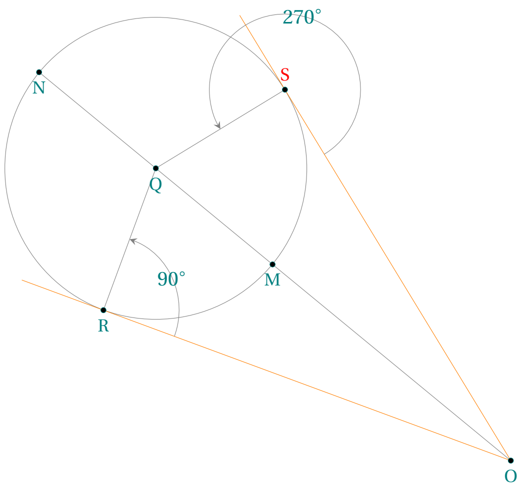
### 14.1.9. Tangent passing through a point on the circle **tangent at**



```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(6,6){E}
  \tkzDefRandPointOn[circle=center O radius 3]
  \tkzGetPoint{A}
  \tkzDrawSegment(O,A)
  \tkzDrawCircle(O,A)
  \tkzDefLine[tangent at=A](O)
  \tkzGetPoint{h}
  \tkzDrawLine[add = 4 and 3](A,h)
  \tkzMarkRightAngle[fill=teal!30](O,A,h)
\end{tikzpicture}
```

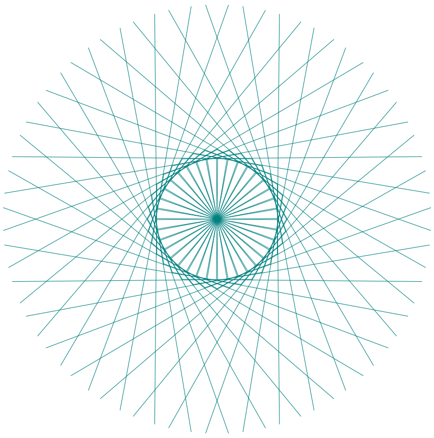
### 14.1.10. Choice of contact point with tangents passing through an external point option **tangent from**

The tangent is not drawn. With option **at**, a point of the tangent is given by **tkzPointResult**. With option **from** you get two points of the circle with **tkzFirstPointResult** and **tkzSecondPointResult**. You can choose between these two points by comparing the angles formed with the outer point, the contact point and the center. The two possible angles have different directions. Angle counterclockwise refers to **tkzFirstPointResult**.



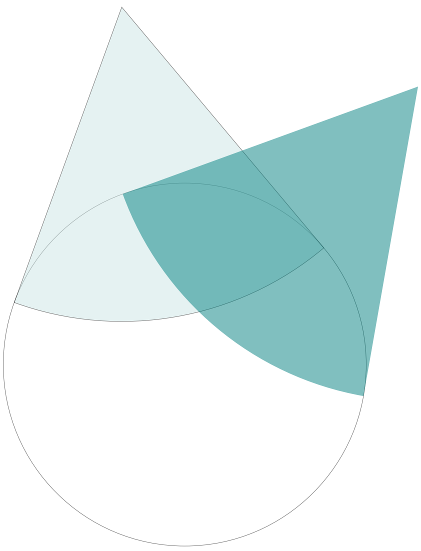

```
\begin{tikzpicture}[scale=1,rotate=-30]
\tkzDefPoints{0/0/Q,0/2/A,6/-1/O}
\tkzDefLine[tangent from = O](Q,A)
\tkzGetPoints{R}{S}
\tkzInterLC[near](O,Q)(Q,A)
\tkzGetPoints{M}{N}
\tkzDrawCircle(Q,M)
\tkzDrawSegments[new,add = 0 and .2](O,R O,S)
\tkzDrawSegments[gray](N,O R,Q S,Q)
\tkzDrawPoints(O,Q,R,S,M,N)
\tkzMarkAngle[gray,-stealth,size=1](O,R,Q)
\tkzFindAngle(O,R,Q)    \tkzGetAngle{an}
\tkzLabelAngle(O,R,Q){%
    $\pgfmathprintnumber{\an}^\circ$}
\tkzMarkAngle[gray,-stealth,size=1](O,S,Q)
\tkzFindAngle(O,S,Q)    \tkzGetAngle{an}
\tkzLabelAngle(O,S,Q){%
    $\pgfmathprintnumber{\an}^\circ$}
\tkzLabelPoints(Q,O,M,N,R)
\tkzLabelPoints[above,text=red](S)
\end{tikzpicture}
```

### 14.1.11. Example of tangents passing through an external point



```
\begin{tikzpicture}[scale=.8]
\tkzDefPoints{0/0/c,1/0/d,3/0/a0}
\def\tkzRadius{1}
\tkzDrawCircle(c,d)
 \foreach \an in {0,10,...,350}{
  \tkzDefPointBy[rotation=center c angle \an](a0)
  \tkzGetPoint{a}
  \tkzDefLine[tangent from = a](c,d)
  \tkzGetPoints{e}{f}
  \tkzDrawLines(a,f a,e)
  \tkzDrawSegments(c,e c,f)}
\end{tikzpicture}
```

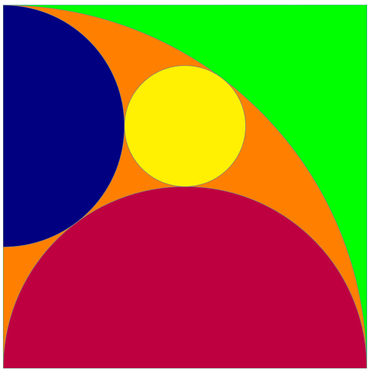
### 14.1.12. Example of Andrew Mertz



```
 \begin{tikzpicture}[scale=.6]
 \tkzDefPoint(100:8){A}\tkzDefPoint(50:8){B}
 \tkzDefPoint(0,0){C} \tkzDefPoint(0,-4){R}
 \tkzDrawCircle(C,R)
 \tkzDefLine[tangent from = A](C,R)  \tkzGetPoints{D}{E}
\tkzDefLine[tangent from = B](C,R)  \tkzGetPoints{F}{G}
 \tkzDrawSector[fill=teal!20,opacity=0.5](A,E)(D)
 \tkzFillSector[color=teal,opacity=0.5](B,G)(F)
 \end{tikzpicture}
```

http://www.texample.net/tikz/examples/

### 14.1.13. Drawing a tangent option tangent from



```
\begin{tikzpicture}[scale=.6]
 \tkzDefPoint(0,0){B}
 \tkzDefPoint(0,8){A}
 \tkzDefSquare(A,B)
 \tkzGetPoints{C}{D}
 \tkzDrawPolygon(A,B,C,D)
 \tkzClipPolygon(A,B,C,D)
 \tkzDefPoint(4,8){F}
 \tkzDefPoint(4,0){E}
 \tkzDefPoint(4,4){Q}
 \tkzFillPolygon[color = green](A,B,C,D)
 \tkzDrawCircle[fill = orange](B,A)
 \tkzDrawCircle[fill = purple](E,B)
 \tkzDefLine[tangent from = B](F,A)
 \tkzInterLL(F,tkzSecondPointResult)(C,D)
 \tkzInterLL(A,tkzPointResult)(F,E)
 \tkzDrawCircle[fill = yellow](tkzPointResult,Q)
 \tkzDefPointBy[projection= onto B--A](tkzPointResult)
 \tkzDrawCircle[fill = blue!50!black](tkzPointResult,A)
\end{tikzpicture}
```

## 15. Triangles

### 15.1. Definition of triangles \tkzDefTriangle

The following macros will allow you to define or construct a triangle from **at least** two points.
At the moment, it is possible to define the following triangles:

- **two angles** determines a triangle with two angles;
- **equilateral** determines an equilateral triangle;
- **isosceles right** determines an isoxsceles right triangle;
- **half** determines a right-angled triangle such that the ratio of the measurements of the two adjacent sides to the right angle is equal to 2;
- **pythagore** determines a right-angled triangle whose side measurements are proportional to 3, 4 and 5;
- **school** determines a right-angled triangle whose angles are 30, 60 and 90 degrees;
- **golden** determines a right-angled triangle such that the ratio of the measurements on the two adjacent sides to the right angle is equal to $\Phi = 1.618034$, I chose "golden triangle" as the denomination because it comes from the golden rectangle and I kept the denomination "gold triangle" or "Euclid's triangle" for the isosceles triangle whose angles at the base are 72 degrees;
- **euclid** or **gold** for the gold triangle; in the previous version the option was "euclide" with an "e".
- **cheops** determines a third point such that the triangle is isosceles with side measurements proportional to 2, $\Phi$ and $\Phi$.

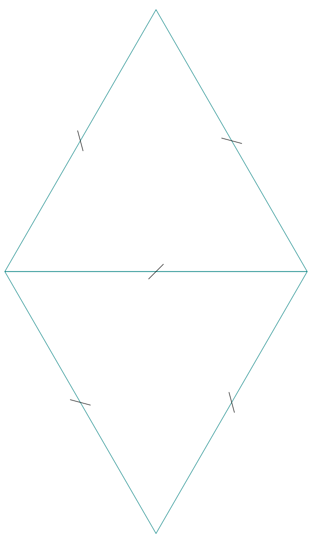
`\tkzDefTriangle[⟨local options⟩](⟨A,B⟩)`

The points are ordered because the triangle is constructed following the direct direction of the trigonometric circle. This macro is either used in partnership with `\tkzGetPoint` or by using `tkzPointResult` if it is not necessary to keep the name.

| options | default | definition |
|---|---|---|
| two angles= #1 and #2 | no defaut | triangle knowing two angles |
| equilateral | equilateral | equilateral triangle |
| half | equilateral | B rectangle $AB = 2BC$ AC hypothenuse |
| isosceles right | equilateral | isosceles right triangle |
| pythagore | equilateral | proportional to the pythagorean triangle 3-4-5 |
| pythagoras | equilateral | same as above |
| egyptian | equilateral | same as above |
| school | equilateral | angles of 30, 60 and 90 degrees |
| gold | equilateral | B rectangle and $AB/AC = \Phi$ |
| euclid | equilateral | angles of 72, 72 and 36 degrees, A is the apex |
| golden | equilateral | angles of 72, 72 and 36 degrees, C is the apex |
| sublime | equilateral | angles of 72, 72 and 36 degrees, C is the apex |
| cheops | equilateral | AC=BC, AC and BC are proportional to 2 and $\Phi$. |
| swap | false | gives the symmetric point with respect to AB |

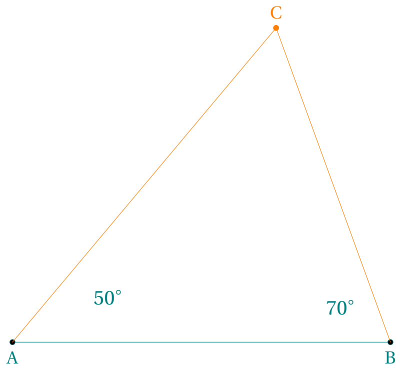
*`\tkzGetPoint` allows you to store the point otherwise `tkzPointResult` allows for immediate use.*

#### 15.1.1. Option equilateral



```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(4,0){B}
  \tkzDefTriangle[equilateral](A,B)
  \tkzGetPoint{C}
  \tkzDrawPolygons(A,B,C)
  \tkzDefTriangle[equilateral](B,A)
  \tkzGetPoint{D}
  \tkzDrawPolygon(B,A,D)
  \tkzMarkSegments[mark=s|](A,B B,C A,C A,D B,D)
\end{tikzpicture}
```

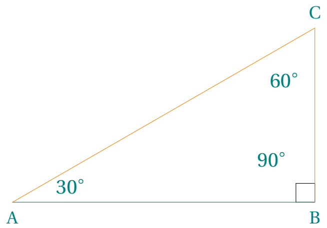
### 15.1.2. Option two angles




```
\begin{tikzpicture}
\tkzDefPoint(0,0){A}
\tkzDefPoint(5,0){B}
\tkzDefTriangle[two angles = 50 and 70](A,B)
\tkzGetPoint{C}
\tkzDrawSegment(A,B)
\tkzDrawPoints(A,B)
\tkzLabelPoints(A,B)
\tkzDrawSegments[new](A,C B,C)
\tkzDrawPoints[new](C)
\tkzLabelPoints[above,new](C)
\tkzLabelAngle[pos=1.4](B,A,C){$50^\circ$}
\tkzLabelAngle[pos=0.8](C,B,A){$70^\circ$}
\end{tikzpicture}
```

### 15.1.3. Option school

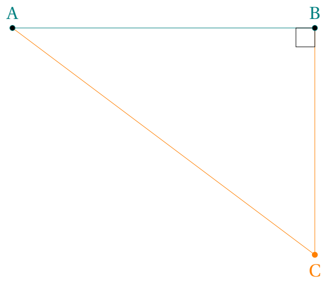
The angles are 30, 60 and 90 degrees.




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDefTriangle[school](A,B)
  \tkzGetPoint{C}
  \tkzMarkRightAngles(C,B,A)
  \tkzLabelAngle[pos=0.8](B,A,C){$30^\circ$}
  \tkzLabelAngle[pos=0.8](C,B,A){$90^\circ$}
  \tkzLabelAngle[pos=0.8](A,C,B){$60^\circ$}
  \tkzDrawSegments(A,B)
  \tkzDrawSegments[new](A,C B,C)
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[above](C)
\end{tikzpicture}
```

### 15.1.4. Option pythagore

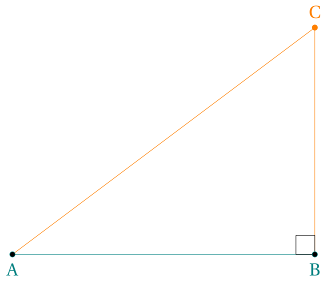
This triangle has sides whose lengths are proportional to 3, 4 and 5.




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDefTriangle[pythagore](A,B)
  \tkzGetPoint{C}
  \tkzDrawSegments(A,B)
  \tkzDrawSegments[new](A,C B,C)
  \tkzMarkRightAngles(A,B,C)
  \tkzDrawPoints[new](C)
  \tkzDrawPoints(A,B)
  \tkzLabelPoints[above](A,B)
  \tkzLabelPoints[new](C)
\end{tikzpicture}
```

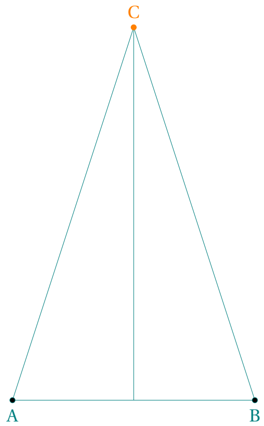
### 15.1.5. Option pythagore and swap

This triangle has sides whose lengths are proportional to 3, 4 and 5.




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDefTriangle[pythagore,swap](A,B)
  \tkzGetPoint{C}
  \tkzDrawSegments(A,B)
  \tkzDrawSegments[new](A,C B,C)
  \tkzMarkRightAngles(A,B,C)
  \tkzLabelPoint[above,new](C){$C$}
  \tkzDrawPoints[new](C)
  \tkzDrawPoints(A,B)
  \tkzLabelPoints(A,B)
\end{tikzpicture}
```

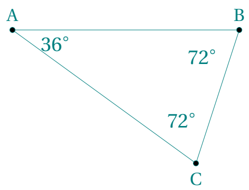
### 15.1.6. Option golden




```
\begin{tikzpicture}[scale=.8]
\tkzDefPoint(0,0){A} \tkzDefPoint(4,0){B}
\tkzDefTriangle[golden](A,B)\tkzGetPoint{C}
\tkzDefSpcTriangle[in,name=M](A,B,C){a,b,c}
\tkzDrawPolygon(A,B,C)
\tkzDrawPoints(A,B)
\tkzDrawSegment(C,Mc)
\tkzDrawPoints[new](C)
\tkzLabelPoints(A,B)
\tkzLabelPoints[above,new](C)
\end{tikzpicture}
```

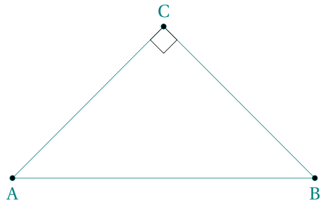
### 15.1.7. Option euclid

Euclid and golden are identical but the segment AB is a base in one and a side in the other.



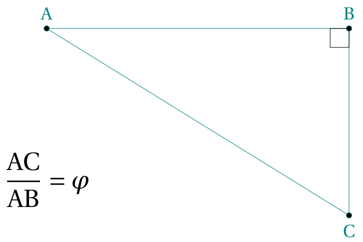

```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoint(0,0){A} \tkzDefPoint(4,0){B}
 \tkzDefTriangle[euclid](A,B)\tkzGetPoint{C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPoints(A,B,C)
 \tkzLabelPoints(C)
 \tkzLabelPoints[above](A,B)
 \tkzLabelAngle[pos=0.8](A,B,C){$72^\circ$}
 \tkzLabelAngle[pos=0.8](B,C,A){$72^\circ$}
 \tkzLabelAngle[pos=0.8](C,A,B){$36^\circ$}
\end{tikzpicture}
```

### 15.1.8. Option isosceles right




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(4,0){B}
  \tkzDefTriangle[isosceles right](A,B)
  \tkzGetPoint{C}
  \tkzDrawPolygons(A,B,C)
  \tkzDrawPoints(A,B,C)
  \tkzMarkRightAngles(A,C,B)
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[above](C)
\end{tikzpicture}
```

### 15.1.9. Option gold




```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,4/0/B}
 \tkzDefTriangle[gold](A,B)
 \tkzGetPoint{C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPoints(A,B,C)
 \tkzLabelPoints[above](A,B)
 \tkzLabelPoints[below](C)
 \tkzMarkRightAngle(A,B,C)
 \tkzText(0,-2){$\dfrac{AC}{AB}=\varphi$}
\end{tikzpicture}
```

### 15.2. Specific triangles with \tkzDefSpcTriangle

The centers of some triangles have been defined in the "points" section, here it is a question of determining the three vertices of specific triangles.

`\tkzDefSpcTriangle[⟨local options⟩](⟨p1,p2,p3⟩){⟨r1,r2,r3⟩}`

The order of the points is important! p1p2p3 defines a triangle then the result is a triangle whose vertices have as reference a combination with **name** and r1,r2, r3. If **name** is empty then the references are r1,r2 and r3.

| options | default | definition |
|---|---|---|
| orthic | centroid | determined by endpoints of the altitudes ... |
| centroid or medial | centroid | intersection of the triangle's three triangle medians |
| in or incentral | centroid | determined with the angle bisectors |
| ex or excentral | centroid | determined with the excenters |
| extouch | centroid | formed by the points of tangency with the excircles |
| intouch or contact | centroid | formed by the points of tangency of the incircle each of the vertices |
| euler | centroid | formed by Euler points on the nine-point circle |
| symmedial | centroid | intersection points of the symmedians |
| tangential | centroid | formed by the lines tangent to the circumcircle |
| feuerbach | centroid | formed by the points of tangency of the nine-point ... circle with the excircles |
| name | empty | used to name the vertices |

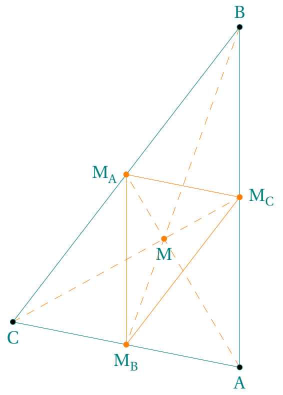
#### 15.2.1. How to name the vertices

With `\tkzDefSpcTriangle[medial,name=M](A,B,C){_A,_B,_C}` you get three vertices named $M_A$, $M_B$ and $M_C$.
With `\tkzDefSpcTriangle[medial](A,B,C){a,b,c}` you get three vertices named and labeled a, b and c.
Possible `\tkzDefSpcTriangle[medial,name=M_](A,B,C){A,B,C}` you get three vertices named $M_A$, $M_B$ and $M_C$.

### 15.3. Option medial or centroid

The geometric centroid of the polygon vertices of a triangle is the point G (sometimes also denoted M) which is also the intersection of the triangle's three triangle medians. The point is therefore sometimes called the median point. The centroid is always in the interior of the triangle.

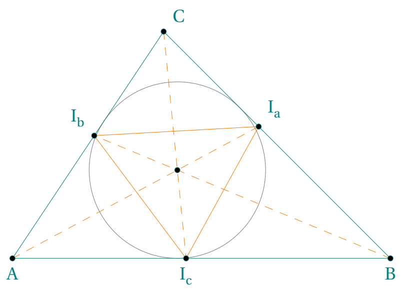
Weisstein, Eric W. "Centroid triangle" From MathWorld–A Wolfram Web Resource.
In the following example, we obtain the Euler circle which passes through the previously defined points.




```
\begin{tikzpicture}[rotate=90,scale=.75]
 \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
 \tkzDefTriangleCenter[centroid](A,B,C)
 \tkzGetPoint{M}
 \tkzDefSpcTriangle[medial,name=M](A,B,C){_A,_B,_C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawSegments[dashed,new](A,M_A B,M_B C,M_C)
 \tkzDrawPolygon[new](M_A,M_B,M_C)
 \tkzDrawPoints(A,B,C)
 \tkzDrawPoints[new](M,M_A,M_B,M_C)
 \tkzLabelPoints[above](B)
 \tkzLabelPoints[below](A,C,M_B)
 \tkzLabelPoints[right](M_C)
 \tkzLabelPoints[left](M_A)
 \tkzLabelPoints[font=\scriptsize](M)
\end{tikzpicture}
```

### 15.3.1. Option `in` or `incentral`

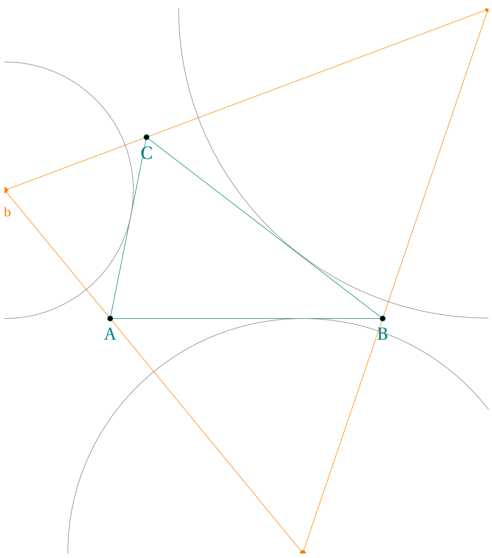
The incentral triangle is the triangle whose vertices are determined by the intersections of the reference triangle's angle bisectors with the respective opposite sides.
Weisstein, Eric W. "Incentral triangle" From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoints{ 0/0/A,5/0/B,2/3/C}
  \tkzDefSpcTriangle[in,name=I](A,B,C){_a,_b,_c}
  \tkzDefCircle[in](A,B,C) \tkzGetPoints{I}{a}
  \tkzDrawCircle(I,a)
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPolygon[new](I_a,I_b,I_c)
  \tkzDrawSegments[dashed,new](A,I_a B,I_b C,I_c)
  \tkzDrawPoints(A,B,C,I,I_a,I_b,I_c)
  \tkzLabelPoints[below](A,B,I_c)
  \tkzLabelPoints[above left](I_b)
  \tkzLabelPoints[above right](C,I_a)
\end{tikzpicture}
```

### 15.3.2. Option `ex` or `excentral`

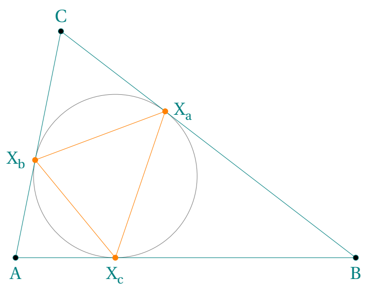
The excentral triangle of a triangle ABC is the triangle $J_aJ_bJ_c$ with vertices corresponding to the excenters of ABC.




```
\begin{tikzpicture}[scale=.6]
 \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
 \tkzDefSpcTriangle[excentral,name=J](A,B,C){_a,_b,_c}
 \tkzDefSpcTriangle[extouch,name=T](A,B,C){_a,_b,_c}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPolygon[new](J_a,J_b,J_c)
 \tkzClipBB
 \tkzDrawPoints(A,B,C)
 \tkzDrawPoints[new](J_a,J_b,J_c)
 \tkzLabelPoints(A,B,C)
 \tkzLabelPoints[new](J_b,J_c)
 \tkzLabelPoints[new,above](J_a)
 \tkzDrawCircles[gray](J_a,T_a J_b,T_b J_c,T_c)
\end{tikzpicture}
```

### 15.3.3. Option `intouch` or `contact`

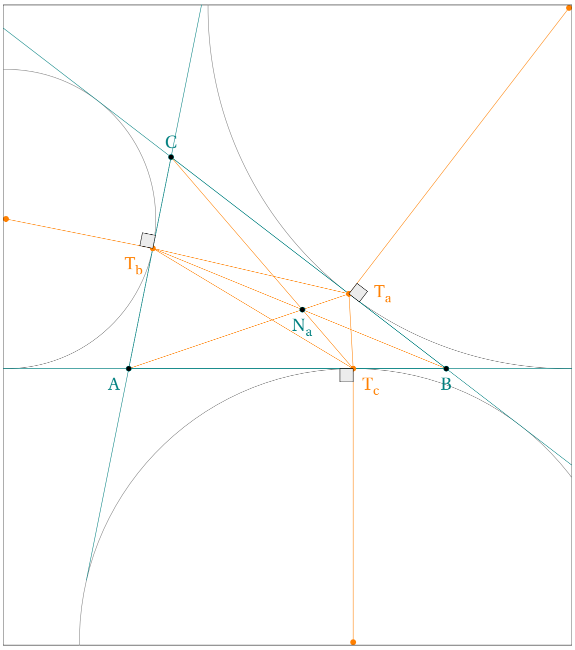
The contact triangle of a triangle ABC, also called the intouch triangle, is the triangle formed by the points of tangency of the incircle of ABC with ABC.
Weisstein, Eric W. "Contact triangle" From MathWorld–A Wolfram Web Resource.
We obtain the intersections of the bisectors with the sides.




```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
 \tkzDefSpcTriangle[intouch,name=X](A,B,C){_a,_b,_c}
 \tkzInCenter(A,B,C)\tkzGetPoint{I}
 \tkzDefCircle[in](A,B,C) \tkzGetPoints{I}{i}
 \tkzDrawCircle(I,i)
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPolygon[new](X_a,X_b,X_c)
 \tkzDrawPoints(A,B,C)
 \tkzDrawPoints[new](X_a,X_b,X_c)
 \tkzLabelPoints[right](X_a)
 \tkzLabelPoints[left](X_b)
 \tkzLabelPoints[above](C)
 \tkzLabelPoints[below](A,B,X_c)
\end{tikzpicture}
```

### 15.3.4. Option `extouch`

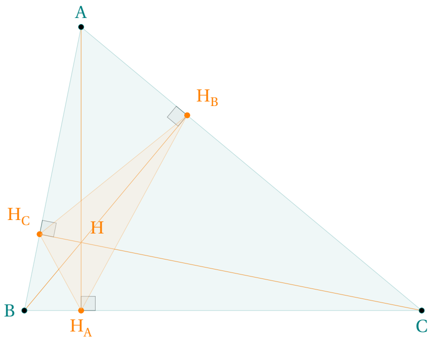
The extouch triangle $T_aT_bT_c$ is the triangle formed by the points of tangency of a triangle ABC with its excircles $J_a$, $J_b$, and $J_c$. The points $T_a$, $T_b$, and $T_c$ can also be constructed as the points which bisect the perimeter of $A_1A_2A_3$ starting at A, B, and C.
Weisstein, Eric W. "Extouch triangle" From MathWorld–A Wolfram Web Resource.
We obtain the points of contact of the exinscribed circles as well as the triangle formed by the centers of the exinscribed circles.




```
\begin{tikzpicture}[scale=.7]
\tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
\tkzDefSpcTriangle[excentral,
                  name=J](A,B,C){_a,_b,_c}
\tkzDefSpcTriangle[extouch,
                   name=T](A,B,C){_a,_b,_c}
\tkzDefTriangleCenter[nagel](A,B,C)
\tkzGetPoint{N_a}
\tkzDefTriangleCenter[centroid](A,B,C)
\tkzGetPoint{G}
\tkzDrawPoints[new](J_a,J_b,J_c)
\tkzClipBB \tkzShowBB
\tkzDrawCircles[gray](J_a,T_a J_b,T_b J_c,T_c)
\tkzDrawLines[add=1 and 1](A,B B,C C,A)
\tkzDrawSegments[new](A,T_a B,T_b C,T_c)
\tkzDrawSegments[new](J_a,T_a J_b,T_b J_c,T_c)
\tkzDrawPolygon(A,B,C)
\tkzDrawPolygon[new](T_a,T_b,T_c)
\tkzDrawPoints(A,B,C,N_a)
\tkzDrawPoints[new](T_a,T_b,T_c)
\tkzLabelPoints[below left](A)
\tkzLabelPoints[below](N_a,B)
\tkzLabelPoints[above](C)
\tkzLabelPoints[new,below left](T_b)
\tkzLabelPoints[new,below right](T_c)
\tkzLabelPoints[new,right=6pt](T_a)
\tkzMarkRightAngles[fill=gray!15](J_a,T_a,B
 J_b,T_b,C J_c,T_c,A)
\end{tikzpicture}
```

### 15.3.5. Option orthic

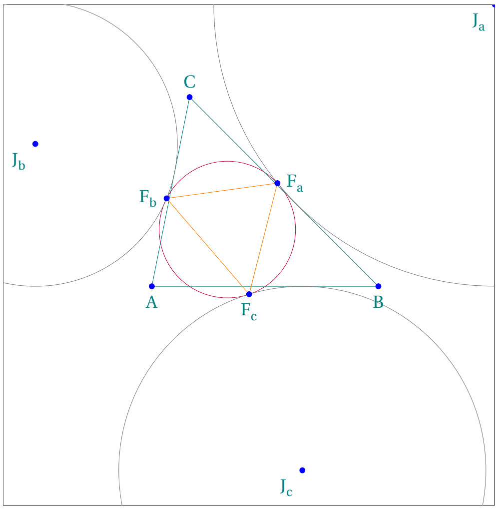
Given a triangle ABC, the triangle $H_AH_BH_C$ whose vertices are endpoints of the altitudes from each of the vertices of ABC is called the orthic triangle, or sometimes the altitude triangle. The three lines $AH_A$, $BH_B$, and $CH_C$ are concurrent at the orthocenter H of ABC.




```
\begin{tikzpicture}[scale=.75]
\tkzDefPoints{1/5/A,0/0/B,7/0/C}
 \tkzDefSpcTriangle[orthic](A,B,C){H_A,H_B,H_C}
 \tkzDefTriangleCenter[ortho](B,C,A)
 \tkzGetPoint{H}
 \tkzDefPointWith[orthogonal,normed](H_A,B)
 \tkzGetPoint{a}
 \tkzDrawSegments[new](A,H_A B,H_B C,H_C)
 \tkzMarkRightAngles[fill=gray!20,
         opacity=.5](A,H_A,C B,H_B,A C,H_C,A)
 \tkzDrawPolygon[fill=teal!20,opacity=.3](A,B,C)
 \tkzDrawPoints(A,B,C)
 \tkzDrawPoints[new](H_A,H_B,H_C)
 \tkzDrawPolygon[new,fill=orange!20,
                opacity=.3](H_A,H_B,H_C)
 \tkzLabelPoints(C)
 \tkzLabelPoints[left](B)
 \tkzLabelPoints[above](A)
 \tkzLabelPoints[new](H_A)
 \tkzLabelPoints[new,above left](H_C)
 \tkzLabelPoints[new,above right](H_B,H)
\end{tikzpicture}
```

### 15.3.6. Option feuerbach

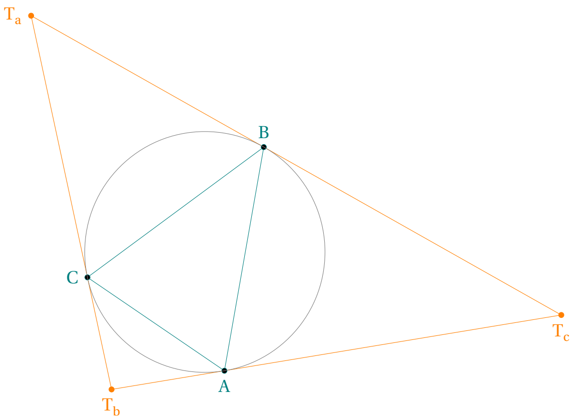
The Feuerbach triangle is the triangle formed by the three points of tangency of the nine-point circle with the excircles.
Weisstein, Eric W. "Feuerbach triangle" From MathWorld–A Wolfram Web Resource.
The points of tangency define the Feuerbach triangle.




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(3,0){B}
  \tkzDefPoint(0.5,2.5){C}
  \tkzDefCircle[euler](A,B,C) \tkzGetPoint{N}
  \tkzDefSpcTriangle[feuerbach,
                     name=F](A,B,C){_a,_b,_c}
  \tkzDefSpcTriangle[excentral,
                     name=J](A,B,C){_a,_b,_c}
  \tkzDefSpcTriangle[extouch,
                      name=T](A,B,C){_a,_b,_c}
  \tkzLabelPoints[below left](J_a,J_b,J_c)
  \tkzClipBB \tkzShowBB
  \tkzDrawCircle[purple](N,F_a)
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPolygon[new](F_a,F_b,F_c)
  \tkzDrawCircles[gray](J_a,F_a J_b,F_b J_c,F_c)
  \tkzDrawPoints[blue](J_a,J_b,J_c,%
          F_a,F_b,F_c,A,B,C)
  \tkzLabelPoints(A,B,F_c)
  \tkzLabelPoints[above](C)
  \tkzLabelPoints[right](F_a)
  \tkzLabelPoints[left](F_b)
\end{tikzpicture}
```

### 15.3.7. Option tangential

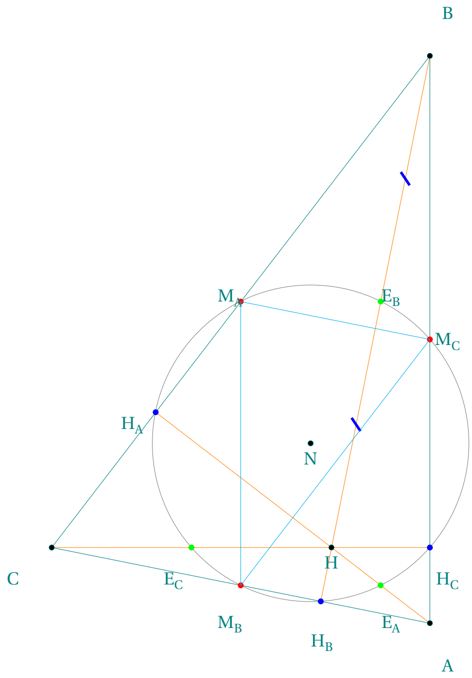
The tangential triangle is the triangle $T_aT_bT_c$ formed by the lines tangent to the circumcircle of a given triangle ABC at its vertices. It is therefore antipedal triangle of ABC with respect to the circumcenter O.
Weisstein, Eric W. "Tangential Triangle." From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}[scale=.5,rotate=80]
  \tkzDefPoints{0/0/A,6/0/B,1.8/4/C}
  \tkzDefSpcTriangle[tangential,
    name=T](A,B,C){_a,_b,_c}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPolygon[new](T_a,T_b,T_c)
  \tkzDrawPoints(A,B,C)
  \tkzDrawPoints[new](T_a,T_b,T_c)
  \tkzDefCircle[circum](A,B,C)
  \tkzGetPoint{O}
  \tkzDrawCircle(O,A)
  \tkzLabelPoints(A)
  \tkzLabelPoints[above](B)
  \tkzLabelPoints[left](C)
  \tkzLabelPoints[new](T_b,T_c)
  \tkzLabelPoints[new,left](T_a)
\end{tikzpicture}
```

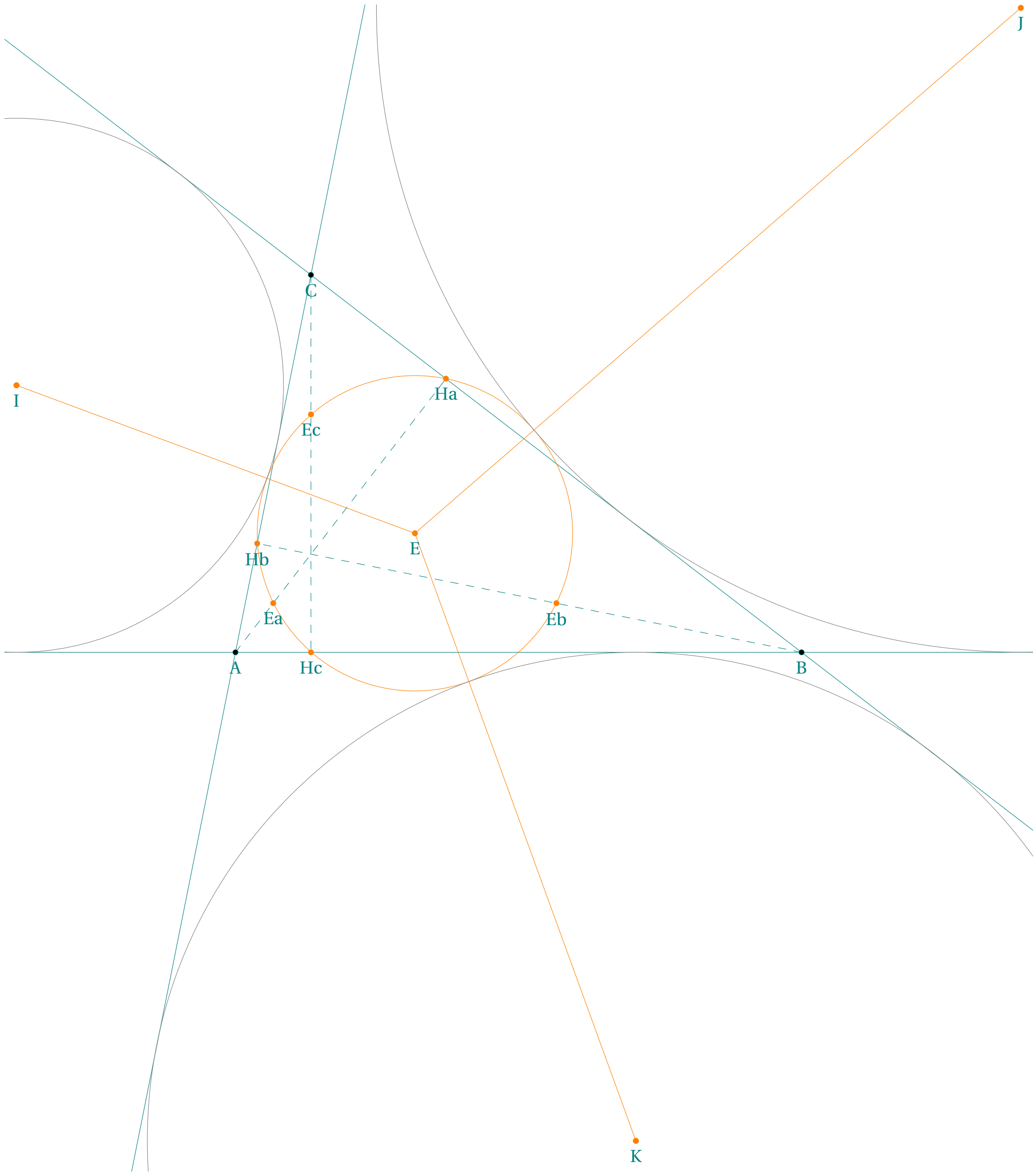
### 15.3.8. Option euler

The Euler triangle of a triangle ABC is the triangle $E_AE_BE_C$ whose vertices are the midpoints of the segments joining the orthocenter H with the respective vertices. The vertices of the triangle are known as the Euler points, and lie on the nine-point circle.
Weisstein, Eric W. "Euler Triangle." From MathWorld–A Wolfram Web Resource.




```
\begin{tikzpicture}[rotate=90,scale=1.25]
 \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
 \tkzDefSpcTriangle[medial,
     name=M](A,B,C){_A,_B,_C}
 \tkzDefTriangleCenter[euler](A,B,C)
     \tkzGetPoint{N} % I= N nine points
 \tkzDefTriangleCenter[ortho](A,B,C)
        \tkzGetPoint{H}
 \tkzDefMidPoint(A,H) \tkzGetPoint{E_A}
 \tkzDefMidPoint(C,H) \tkzGetPoint{E_C}
 \tkzDefMidPoint(B,H) \tkzGetPoint{E_B}
 \tkzDefSpcTriangle[ortho,name=H](A,B,C){_A,_B,_C}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawCircle(N,E_A)
 \tkzDrawSegments[new](A,H_A B,H_B C,H_C)
 \tkzDrawPoints(A,B,C,N,H)
 \tkzDrawPoints[red](M_A,M_B,M_C)
 \tkzDrawPoints[blue]( H_A,H_B,H_C)
 \tkzDrawPoints[green](E_A,E_B,E_C)
 \tkzAutoLabelPoints[center=N,font=\scriptsize]%
(A,B,C,M_A,M_B,M_C,H_A,H_B,H_C,E_A,E_B,E_C)
\tkzLabelPoints[font=\scriptsize](H,N)
\tkzMarkSegments[mark=s|,size=3pt,
  color=blue,line width=1pt](B,E_B E_B,H)
   \tkzDrawPolygon[color=cyan](M_A,M_B,M_C)
\end{tikzpicture}
```

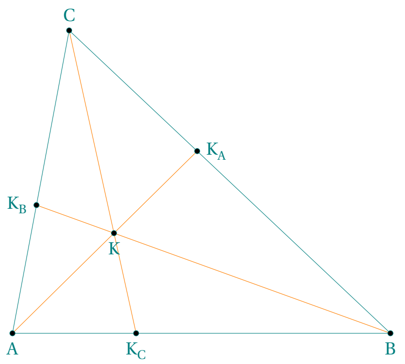
### 15.3.9. Option euler and Option orthic



```
\begin{tikzpicture}[scale=1.25]
  \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
  \tkzDefSpcTriangle[euler,name=E](A,B,C){a,b,c}
  \tkzDefSpcTriangle[orthic,name=H](A,B,C){a,b,c}
  \tkzDefExCircle(A,B,C) \tkzGetPoints{I}{i}
  \tkzDefExCircle(C,A,B) \tkzGetPoints{J}{j}
  \tkzDefExCircle(B,C,A) \tkzGetPoints{K}{k}
  \tkzDrawPoints[orange](I,J,K)
  \tkzLabelPoints[font=\scriptsize](A,B,C,I,J,K)
  \tkzClipBB
  \tkzInterLC(I,C)(I,i) \tkzGetSecondPoint{Fc}
  \tkzInterLC(J,B)(J,j) \tkzGetSecondPoint{Fb}
  \tkzInterLC(K,A)(K,k) \tkzGetSecondPoint{Fa}
  \tkzDrawLines[add=1.5 and 1.5](A,B A,C B,C)
  \tkzDefCircle[euler](A,B,C) \tkzGetPoints{E}{e}
  \tkzDrawCircle[orange](E,e)
  \tkzDrawSegments[orange](E,I E,J E,K)
  \tkzDrawSegments[dashed](A,Ha B,Hb C,Hc)
  \tkzDrawCircles(J,j I,i K,k)
  \tkzDrawPoints(A,B,C)
  \tkzDrawPoints[orange](E,I,J,K,Ha,Hb,Hc,Ea,Eb,Ec,Fa,Fb,Fc)
  \tkzLabelPoints[font=\scriptsize](E,Ea,Eb,Ec,Ha,Hb,Hc,Fa,Fb,Fc)
\end{tikzpicture}
```

### 15.3.10. Option symmedial

The symmedial triangle$K_A K_B K_C$ is the triangle whose vertices are the intersection points of the symmedians with the reference triangle ABC.




```
\begin{tikzpicture}
\tkzDefPoint(0,0){A}
\tkzDefPoint(5,0){B}
\tkzDefPoint(.75,4){C}
\tkzDefTriangleCenter[symmedian](A,B,C)\tkzGetPoint{K}
\tkzDefSpcTriangle[symmedial,name=K_](A,B,C){A,B,C}
\tkzDrawPolygon(A,B,C)
\tkzDrawSegments[new](A,K_A B,K_B C,K_C)
\tkzDrawPoints(A,B,C,K,K_A,K_B,K_C)
\tkzLabelPoints(A,B,K,K_C)
\tkzLabelPoints[above](C)
\tkzLabelPoints[right](K_A)
\tkzLabelPoints[left](K_B)
\end{tikzpicture}
```

## 15.4. Permutation of two points of a triangle

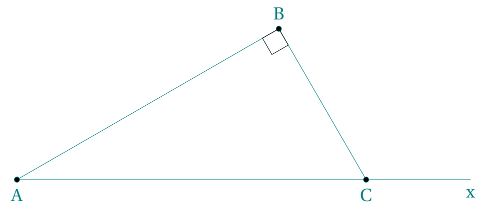
**\tkzPermute(⟨pt1,pt2,pt3⟩)**

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2,pt3) | \tkzPermute(A,B,C) | A, $\widehat{B,A,C}$ are unchanged, B, C exchange their position |

*The triangle is unchanged.*

#### 15.4.1. Modification of the school triangle

This triangle is constructed from the segment [AB] on [A, x).
If we want the segment [AC] to be on [A, x), we just have to swap B and C.




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B,6/0/x}
  \tkzDefTriangle[school](A,B)
  \tkzGetPoint{C}
  \tkzPermute(A,B,C)
  \tkzDrawSegments(A,B C,x)
  \tkzDrawSegments(A,C B,C)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,C,x)
  \tkzLabelPoints[above](B)
  \tkzMarkRightAngles(C,B,A)
\end{tikzpicture}
```

Remark: Only the first point is unchanged. The order of the last two parameters is not important.

## 16. Definition of polygons

### 16.1. Defining the points of a square

We have seen the definitions of some triangles. Let us look at the definitions of some quadrilaterals and regular polygons.

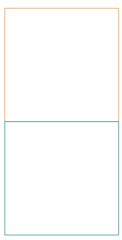
`\tkzDefSquare(⟨pt1,pt2⟩)`

The square is defined in the forward direction. From two points, two more points are obtained such that the four taken in order form a square. The square is defined in the forward direction.
The results are in **tkzFirstPointResult** and **tkzSecondPointResult**.
We can rename them with **\tkzGetPoints**.

| Arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | \tkzDefSquare(⟨A,B⟩) | The square is defined in the direct direction. |

#### 16.1.1. Using \tkzDefSquare with two points

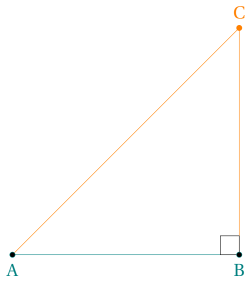
Note the inversion of the first two points and the result.



```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoint(0,0){A} \tkzDefPoint(3,0){B}
  \tkzDefSquare(A,B)
  \tkzDrawPolygon[new](A,B,tkzFirstPointResult,%
                 tkzSecondPointResult)
  \tkzDefSquare(B,A)
  \tkzDrawPolygon(B,A,tkzFirstPointResult,%
                 tkzSecondPointResult)
\end{tikzpicture}
```

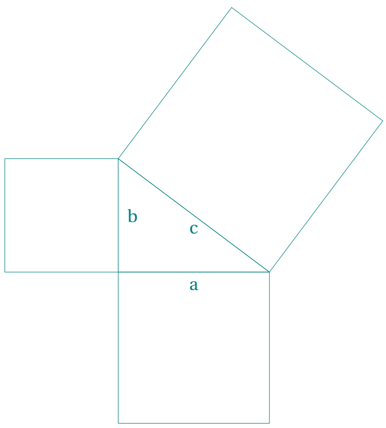
We may only need one point to draw an isosceles right-angled triangle so we use **\tkzGetFirstPoint** or **\tkzGetSecondPoint**.

### 16.1.2. Use of \tkzDefSquare to obtain an isosceles right-angled triangle




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(3,0){B}
  \tkzDefSquare(A,B) \tkzGetFirstPoint{C}
  \tkzDrawSegment(A,B)
  \tkzDrawSegments[new](A,C B,C)
  \tkzMarkRightAngles(A,B,C)
  \tkzDrawPoints(A,B) \tkzDrawPoint[new](C)
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[new,above](C)
\end{tikzpicture}
```

### 16.1.3. Pythagorean Theorem and \tkzDefSquare




```
\begin{tikzpicture}[scale=.5]
\tkzDefPoint(0,0){C}
\tkzDefPoint(4,0){A}
\tkzDefPoint(0,3){B}
\tkzDefSquare(B,A)\tkzGetPoints{E}{F}
\tkzDefSquare(A,C)\tkzGetPoints{G}{H}
\tkzDefSquare(C,B)\tkzGetPoints{I}{J}
\tkzDrawPolygon(A,B,C)
\tkzDrawPolygon(A,C,G,H)
\tkzDrawPolygon(C,B,I,J)
\tkzDrawPolygon(B,A,E,F)
\tkzLabelSegment(A,C){$a$}
\tkzLabelSegment[right](C,B){$b$}
\tkzLabelSegment[swap](A,B){$c$}
\end{tikzpicture}
```

## 16.2. Defining the points of a rectangle

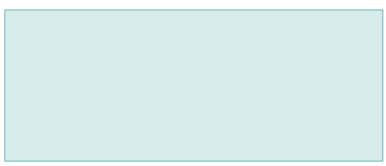
.

**\tkzDefRectangle(⟨pt1,pt2⟩)**

The rectangle is defined in the forward direction. From two points, two more points are obtained such that the four taken in order form a rectangle. The two points passed in arguments are the ends of a diagonal of the rectangle. The sides are parallel to the axes.
The results are in **tkzFirstPointResult** and **tkzSecondPointResult**.
We can rename them with **\tkzGetPoints**.

| Arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | \tkzDefRectangle(⟨A,B⟩) | The rectangle is defined in the direct direction. |

### 16.2.1. Example of a rectangle definition



```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,5/2/C}
\tkzDefRectangle(A,C) \tkzGetPoints{B}{D}
\tkzDrawPolygon[fill=teal!15](A,...,D)
\end{tikzpicture}
```

### 16.3. Definition of parallelogram

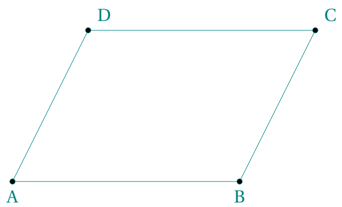
Defining the points of a parallelogram. It is a matter of completing three points in order to obtain a parallelogram.

\tkzDefParallelogram(⟨pt1,pt2,pt3⟩)

| arguments | default | definition |
|---|---|---|
| (⟨pt1,pt2,pt3⟩) | no default | Three points are necessary |

From three points, another point is obtained such that the four taken in order form a parallelogram.
The result is in tkzPointResult.
We can rename it with the name \tkzGetPoint...

#### 16.3.1. Example of a parallelogram definition




```
\begin{tikzpicture}[scale=1]
 \tkzDefPoints{0/0/A,3/0/B,4/2/C}
 \tkzDefParallelogram(A,B,C)
 % or   \tkzDefPointWith[colinear= at C](B,A)
 \tkzGetPoint{D}
 \tkzDrawPolygon(A,B,C,D)
 \tkzLabelPoints(A,B)
 \tkzLabelPoints[above right](C,D)
 \tkzDrawPoints(A,...,D)
\end{tikzpicture}
```

### 16.4. The golden rectangle

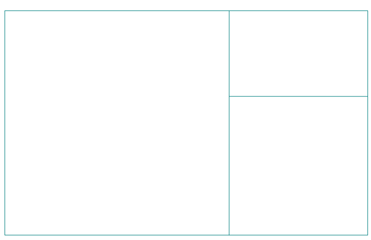
\tkzDefGoldenRectangle(⟨point,point⟩)

The macro determines a rectangle whose size ratio is the number $\Phi$.
The created points are in **tkzFirstPointResult** and **tkzSecondPointResult**.
They can be obtained with the macro **\tkzGetPoints**. The following macro is used to draw the rectangle.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | (⟨A,B⟩) | If C and D are created then $AB/BC = \Phi$. |

**\tkzDefGoldenRectangle** or **\tkzDefGoldRectangle**

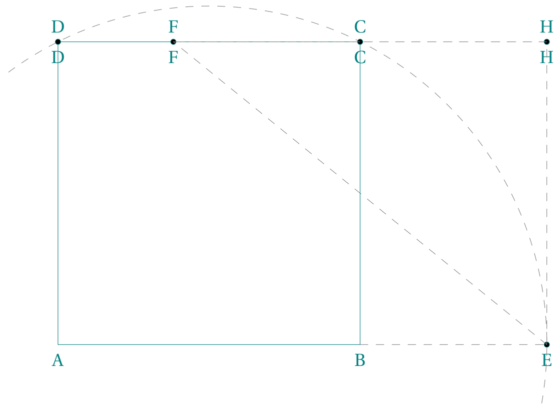
#### 16.4.1. Golden Rectangles



```
\begin{tikzpicture}[scale=.6]
 \tkzDefPoint(0,0){A}       \tkzDefPoint(8,0){B}
 \tkzDefGoldRectangle(A,B) \tkzGetPoints{C}{D}
 \tkzDefGoldRectangle(B,C) \tkzGetPoints{E}{F}
 \tkzDefGoldRectangle(C,E) \tkzGetPoints{G}{H}
 \tkzDrawPolygon(A,B,C,D)
 \tkzDrawSegments(E,F G,H)
\end{tikzpicture}
```

### 16.4.2. Construction of the golden rectangle

Without the previous macro here is how to get the golden rectangle.




```
\begin{tikzpicture}[scale=.5]
\tkzDefPoint(0,0){A}
\tkzDefPoint(8,0){B}
\tkzDefMidPoint(A,B)
\tkzGetPoint{I}
\tkzDefSquare(A,B)\tkzGetPoints{C}{D}
\tkzInterLC(A,B)(I,C)\tkzGetPoints{G}{E}
\tkzDefPointWith[colinear= at C](E,B)
 \tkzGetPoint{F}
\tkzDefPointBy[projection=onto D--C ](E)
 \tkzGetPoint{H}
\tkzDrawArc[style=dashed](I,E)(D)
\tkzDrawPolygon(A,B,C,D)
\tkzDrawPoints(C,D,E,F,H)
\tkzLabelPoints(A,B,C,D,E,F,H)
\tkzLabelPoints[above](C,D,F,H)
\tkzDrawSegments[style=dashed,color=gray]%
(E,F C,F B,E F,H H,C E,H)
\end{tikzpicture}
```

### 16.5. Regular polygon

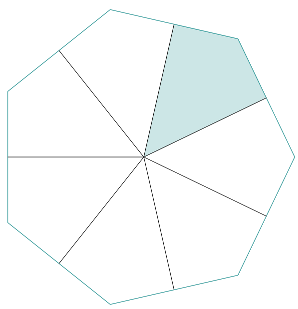
**\tkzDefRegPolygon[⟨local options⟩](⟨pt1,pt2⟩)**

From the number of sides, depending on the options, this macro determines a regular polygon according to its center or one side.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | (⟨O,A⟩) | with option center, O is the center of the polygon. |
| (⟨pt1,pt2⟩) | (⟨A,B⟩) | with option side, [AB] is a side. |

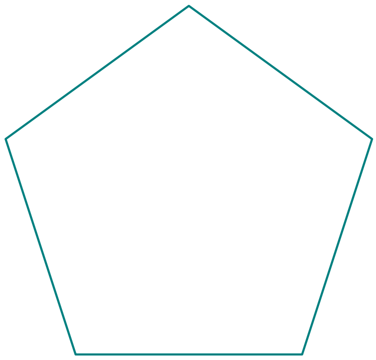
| options | default | example |
|---|---|---|
| name | P | The vertices are named P1,P2,… |
| sides | 5 | number of sides. |
| center | center | The first point is the center. |
| side | center | The two points are vertices. |
| Options TikZ | ... | |

### 16.5.1. Option center



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/P0,0/0/Q0,2/0/P1}
  \tkzDefMidPoint(P0,P1) \tkzGetPoint{Q1}
  \tkzDefRegPolygon[center,sides=7](P0,P1)
  \tkzDefMidPoint(P1,P2) \tkzGetPoint{Q1}
  \tkzDefRegPolygon[center,sides=7,name=Q](P0,Q1)
  \tkzFillPolygon[teal!20](Q0,Q1,P2,Q2)
  \tkzDrawPolygon(P1,P...,P7)
  \foreach \j in {1,...,7} {%
  \tkzDrawSegment[black](P0,Q\j)}
\end{tikzpicture}
```

### 16.5.2. Option side



```
\begin{tikzpicture}[scale=1]
    \tkzDefPoints{-4/0/A, -1/0/B}
    \tkzDefRegPolygon[side,sides=5,name=P](A,B)
    \tkzDrawPolygon[thick](P1,P...,P5)
\end{tikzpicture}
```

# 17. Circles

Among the following macros, one will allow you to draw a circle, which is not a real feat. To do this, you will need to know the center of the circle and either the radius of the circle or a point on the circumference. It seemed to me that the most frequent use was to draw a circle with a given center passing through a given point. This will be the default method, otherwise you will have to use the `R` option. There are a large number of special circles, for example the circle circumscribed by a triangle.

- I have created a first macro `\tkzDefCircle` which allows, according to a particular circle, to retrieve its center and the measurement of the radius in cm. This recovery is done with the macros `\tkzGetPoint` and `\tkzGetLength`;
- then a macro `\tkzDrawCircle`;
- then a macro that allows you to color in a disc, but without drawing the circle `\tkzFillCircle`;
- sometimes, it is necessary for a drawing to be contained in a disk, this is the role assigned to `\tkzClipCircle`;
- it finally remains to be able to give a label to designate a circle and if several possibilities are offered, we will see here `\tkzLabelCircle`.

## 17.1. Characteristics of a circle: \tkzDefCircle

This macro allows you to retrieve the characteristics (center and radius) of certain circles.

`\tkzDefCircle[⟨local options⟩](⟨A,B⟩) or (⟨A,B,C⟩)`

Attention the arguments are lists of two or three points. This macro is either used in partnership with `\tkzGetPoints` to obtain the center and a point on the circle, or by using `tkzFirstPointResult` and `tkzSecondPointResult` if it is not necessary to keep the results. You can also use `\tkzGetLength` to get the radius.

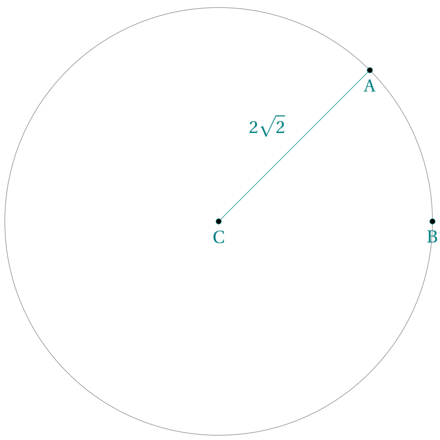
| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) or (⟨pt1,pt2,pt3⟩) | (⟨A,B⟩) | [AB] is radius A is the center |

| options | default | definition |
|---|---|---|
| R | circum | circle characterized by a center and a radius |
| diameter | circum | circle characterized by two points defining a diameter |
| circum | circum | circle circumscribed of a triangle |
| in | circum | incircle a triangle |
| ex | circum | excircle of a triangle |
| euler or nine | circum | Euler's Circle |
| spieker | circum | Spieker Circle |
| apollonius | circum | circle of Apollonius |
| orthogonal from | circum | [orthogonal from = A ](O,M) |
| orthogonal through | circum | [orthogonal through = A and B](O,M) |
| K | 1 | coefficient used for a circle of Apollonius |

*In the following examples, I draw the circles with a macro not yet presented. You may only need the center and a point on the circle.*

### 17.1.1. Example with option R

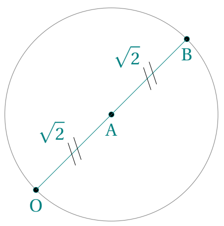
We obtain with the macro `\tkzGetPoint` a point of the circle which is the East pole.




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(3,3){C}
  \tkzDefPoint(5,5){A}
   \tkzCalcLength(A,C) \tkzGetLength{rAC}
  \tkzDefCircle[R](C,\rAC) \tkzGetPoint{B}
  \tkzDrawCircle(C,B)
  \tkzDrawSegment(C,A)
  \tkzLabelSegment[above left](C,A){$2\sqrt{2}$}
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,C,B)
\end{tikzpicture}
```

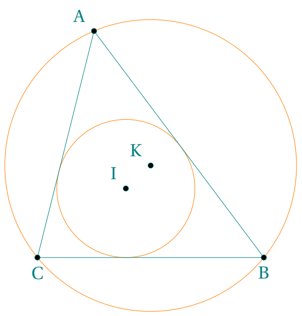
### 17.1.2. Example with option diameter

It is simpler here to search directly for the middle of [AB]. The result is the center and if necessary




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,2){B}
  \tkzDefCircle[diameter](O,B) \tkzGetPoint{A}
  \tkzDrawCircle(A,B)
  \tkzDrawPoints(O,A,B)
  \tkzDrawSegment(O,B)
  \tkzLabelPoints(O,A,B)
  \tkzLabelSegment[above left](O,A){$\sqrt{2}$}
  \tkzLabelSegment[above left](A,B){$\sqrt{2}$}
  \tkzMarkSegments[mark=s||](O,A A,B)
\end{tikzpicture}
```

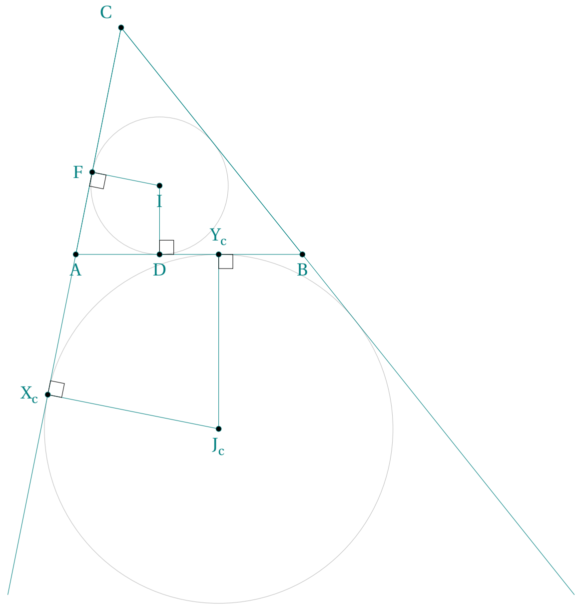
### 17.1.3. Circles inscribed and circumscribed for a given triangle




```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoint(2,2){A}  \tkzDefPoint(5,-2){B}
 \tkzDefPoint(1,-2){C}
 \tkzDefCircle[in](A,B,C)
 \tkzGetPoints{I}{x}
 \tkzDefCircle[circum](A,B,C)
 \tkzGetPoint{K}
 \tkzDrawCircles[new](I,x K,A)
 \tkzLabelPoints[below](B,C)
 \tkzLabelPoints[above left](A,I,K)
 \tkzDrawPolygon(A,B,C)
 \tkzDrawPoints(A,B,C,I,K)
\end{tikzpicture}
```

### 17.1.4. Example with option ex

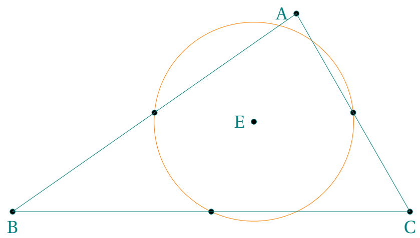
We want to define an excircle of a triangle relatively to point C




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{ 0/0/A,4/0/B,0.8/4/C}
  \tkzDefCircle[ex](B,C,A)
  \tkzGetPoints{J_c}{h}
  \tkzDefPointBy[projection=onto A--C ](J_c)
  \tkzGetPoint{X_c}
  \tkzDefPointBy[projection=onto A--B ](J_c)
  \tkzGetPoint{Y_c}
  \tkzDefCircle[in](A,B,C)
  \tkzGetPoints{I}{y}
  \tkzDrawCircles[color=lightgray](J_c,h I,y)
  \tkzDefPointBy[projection=onto A--C ](I)
  \tkzGetPoint{F}
  \tkzDefPointBy[projection=onto A--B ](I)
  \tkzGetPoint{D}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawLines[add=0 and 1.5](C,A C,B)
  \tkzDrawSegments(J_c,X_c I,D  I,F J_c,Y_c)
  \tkzMarkRightAngles(A,F,I B,D,I J_c,X_c,A%
     J_c,Y_c,B)
  \tkzDrawPoints(B,C,A,I,D,F,X_c,J_c,Y_c)
  \tkzLabelPoints(B,A,J_c,I,D)
  \tkzLabelPoints[above](Y_c)
  \tkzLabelPoints[left](X_c)
  \tkzLabelPoints[above left](C)
  \tkzLabelPoints[left](F)
\end{tikzpicture}
```

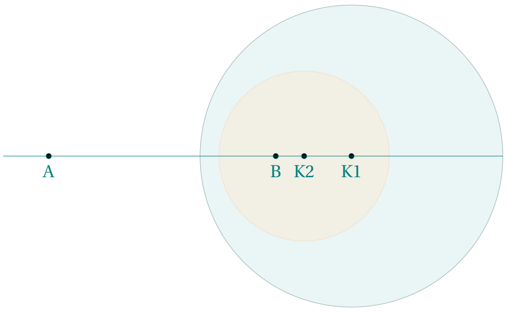
### 17.1.5. Euler's circle for a given triangle with option euler

We verify that this circle passes through the middle of each side.




```
\begin{tikzpicture}[scale=.75]
   \tkzDefPoint(5,3.5){A}
   \tkzDefPoint(0,0){B} \tkzDefPoint(7,0){C}
   \tkzDefCircle[euler](A,B,C)
   \tkzGetPoints{E}{e}
   \tkzDefSpcTriangle[medial](A,B,C){M_a,M_b,M_c}
   \tkzDrawCircle[new](E,e)
   \tkzDrawPoints(A,B,C,E,M_a,M_b,M_c)
   \tkzDrawPolygon(A,B,C)
   \tkzLabelPoints[below](B,C)
   \tkzLabelPoints[left](A,E)
\end{tikzpicture}
```

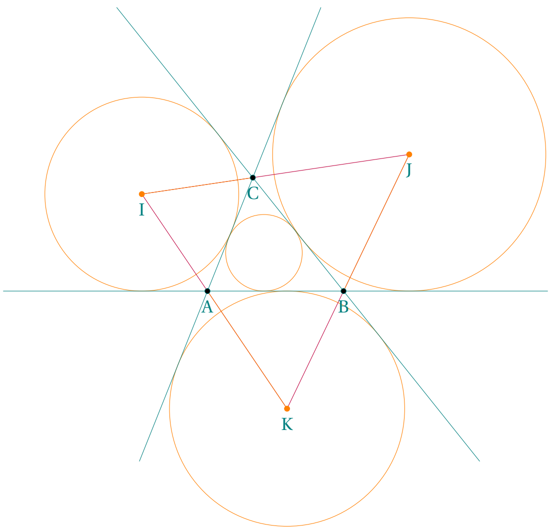
### 17.1.6. Apollonius circles for a given segment option `apollonius`




```
\begin{tikzpicture}[scale=0.75]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(4,0){B}
  \tkzDefCircle[apollonius,K=2](A,B)
  \tkzGetPoints{K1}{x}
  \tkzDrawCircle[color = teal!50!black,
      fill=teal!20,opacity=.4](K1,x)
  \tkzDefCircle[apollonius,K=3](A,B)
  \tkzGetPoints{K2}{y}
  \tkzDrawCircle[color=orange!50,
      fill=orange!20,opacity=.4](K2,y)
  \tkzLabelPoints[below](A,B,K1,K2)
  \tkzDrawPoints(A,B,K1,K2)
  \tkzDrawLine[add=.2 and 1](A,B)
\end{tikzpicture}
```

### 17.1.7. Circles exinscribed to a given triangle option `ex`

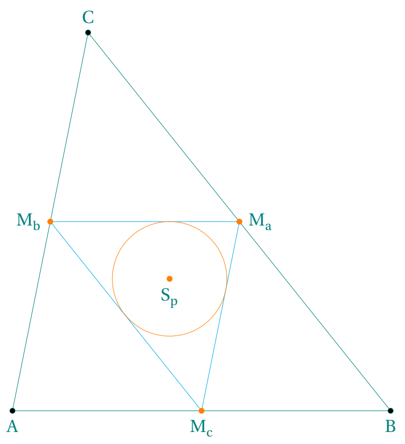
You can also get the center and the projection of it on one side of the triangle.
with `\tkzGetFirstPoint{Jb}` and `\tkzGetSecondPoint{Tb}`.




```
\begin{tikzpicture}[scale=.6]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(3,0){B}
  \tkzDefPoint(1,2.5){C}
  \tkzDefCircle[ex](A,B,C) \tkzGetPoints{I}{i}
  \tkzDefCircle[ex](C,A,B) \tkzGetPoints{J}{j}
  \tkzDefCircle[ex](B,C,A) \tkzGetPoints{K}{k}
  \tkzDefCircle[in](B,C,A) \tkzGetPoints{O}{o}
  \tkzDrawCircles[new](J,j I,i K,k O,o)
  \tkzDrawLines[add=1.5 and 1.5](A,B A,C B,C)
  \tkzDrawPolygon[purple](I,J,K)
  \tkzDrawSegments[new](A,K B,J C,I)
  \tkzDrawPoints(A,B,C)
  \tkzDrawPoints[new](I,J,K)
  \tkzLabelPoints(A,B,C,I,J,K)
\end{tikzpicture}
```

### 17.1.8. Spieker circle with option `spieker`

The incircle of the medial triangle $M_aM_bM_c$ is the Spieker circle:




```
\begin{tikzpicture}[scale=1.25]
  \tkzDefPoints{ 0/0/A,4/0/B,0.8/4/C}
  \tkzDefSpcTriangle[medial](A,B,C){M_a,M_b,M_c}
  \tkzDefTriangleCenter[spieker](A,B,C)
  \tkzGetPoint{S_p}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPolygon[cyan](M_a,M_b,M_c)
  \tkzDrawPoints(B,C,A)
  \tkzDefCircle[spieker](A,B,C)
  \tkzDrawPoints[new](M_a,M_b,M_c,S_p)
  \tkzDrawCircle[new](tkzFirstPointResult,%
    tkzSecondPointResult)
  \tkzLabelPoints[right](M_a)
  \tkzLabelPoints[left](M_b)
  \tkzLabelPoints[below](A,B,M_c,S_p)
  \tkzLabelPoints[above](C)
\end{tikzpicture}
```

## 17.2. Projection of excenters

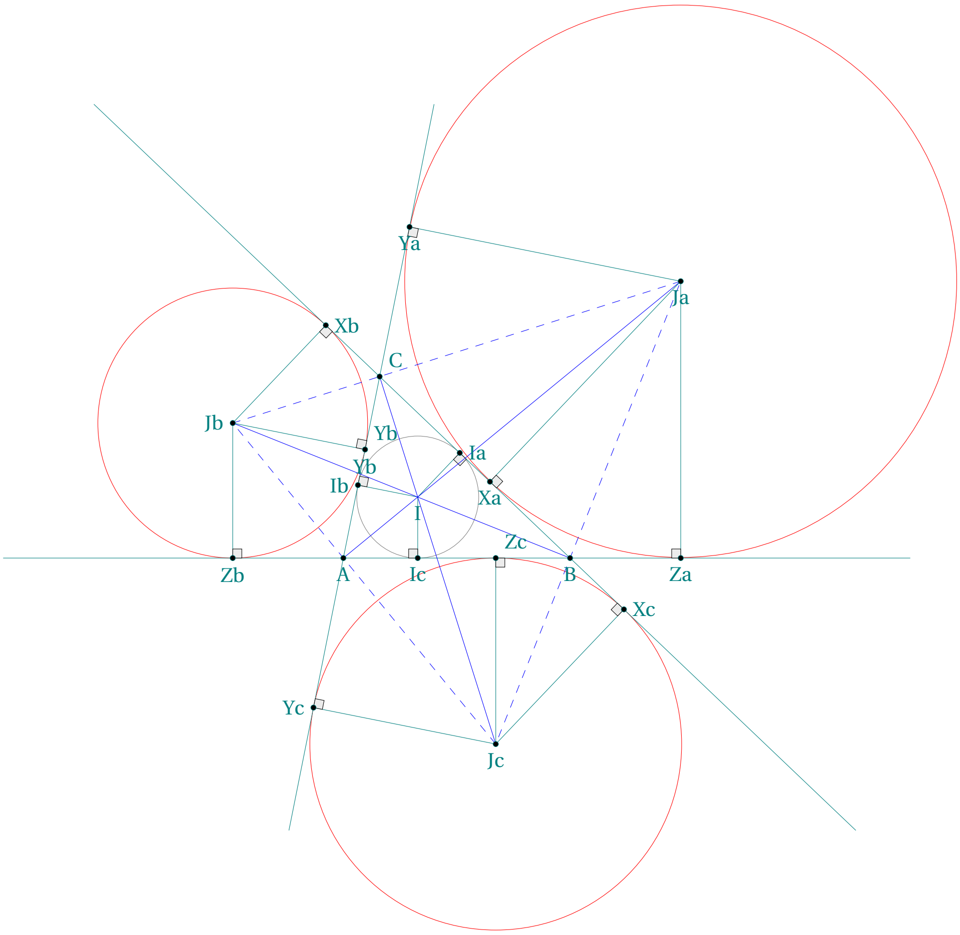
`\tkzDefProjExcenter[⟨local options⟩](⟨A,B,C⟩)(⟨a,b,c⟩){⟨X,Y,Z⟩}`

Each excenter has three projections on the sides of the triangle ABC. We can do this with one macro `\tkzDefProjExcenter[name=J](A,B,C)(a,b,c){Y,Z,X}`.

| options | default | definition |
|---|---|---|
| name | no defaut | used to name the vertices |

| arguments | default | definition |
|---|---|---|
| (pt1=$\alpha_1$,pt2=$\alpha_2$,...) | no default | Each point has a assigned weight |

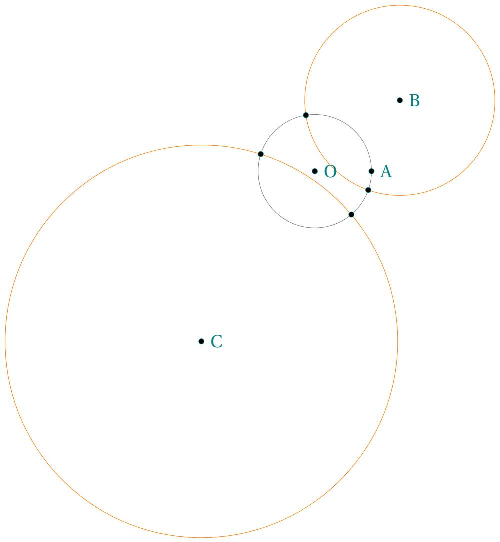
### 17.2.1. Excircles



```
\begin{tikzpicture}[scale=.6]
\tikzset{line style/.append style={line width=.2pt}}
\tikzset{label style/.append style={color=teal,font=\footnotesize}}
\tkzDefPoints{0/0/A,5/0/B,0.8/4/C}
\tkzDefSpcTriangle[excentral,name=J](A,B,C){a,b,c}
\tkzDefSpcTriangle[intouch,name=I](A,B,C){a,b,c}
\tkzDefProjExcenter[name=J](A,B,C)(a,b,c){X,Y,Z}
\tkzDefCircle[in](A,B,C)   \tkzGetPoint{I} \tkzGetSecondPoint{T}
\tkzDrawCircles[red](Ja,Xa Jb,Yb Jc,Zc)
\tkzDrawCircle(I,T)
\tkzDrawPolygon[dashed,color=blue](Ja,Jb,Jc)
\tkzDrawLines[add=1.5 and 1.5](A,C A,B B,C)
\tkzDrawSegments(Ja,Xa Ja,Ya Ja,Za
                 Jb,Xb Jb,Yb Jb,Zb
                 Jc,Xc Jc,Yc Jc,Zc
                 I,Ia I,Ib I,Ic)
\tkzMarkRightAngles[size=.2,fill=gray!15](Ja,Za,B Ja,Xa,B Ja,Ya,C Jb,Yb,C)
\tkzMarkRightAngles[size=.2,fill=gray!15](Jb,Zb,B Jb,Xb,C Jc,Yc,A Jc,Zc,B)
\tkzMarkRightAngles[size=.2,fill=gray!15](Jc,Xc,C I,Ia,B I,Ib,C I,Ic,A)
\tkzDrawSegments[blue](Jc,C Ja,A Jb,B)
\tkzDrawPoints(A,B,C,Xa,Xb,Xc,Ja,Jb,Jc,Ia,Ib,Ic,Ya,Yb,Yc,Za,Zb,Zc)
\tkzLabelPoints(A,Ya,Yb,Ja,I)
\tkzLabelPoints[left](Jb,Ib,Yc)
\tkzLabelPoints[below](Zb,Ic,Jc,B,Za,Xa)
\tkzLabelPoints[above right](C,Zc,Yb)
\tkzLabelPoints[right](Xb,Ia,Xc)
\end{tikzpicture}
```

### 17.2.2. Orthogonal from

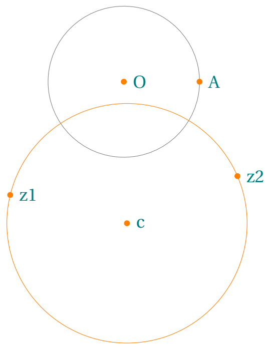
Orthogonal circle of given center. `\tkzGetPoints{z1}{z2}` gives two points of the circle.




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/O,1/0/A}
  \tkzDefPoints{1.5/1.25/B,-2/-3/C}
  \tkzDefCircle[orthogonal from=B](O,A)
  \tkzGetPoints{z1}{z2}
  \tkzDefCircle[orthogonal from=C](O,A)
  \tkzGetPoints{t1}{t2}
  \tkzDrawCircle(O,A)
  \tkzDrawCircles[new](B,z1 C,t1)
  \tkzDrawPoints(t1,t2,C)
  \tkzDrawPoints(z1,z2,O,A,B)
  \tkzLabelPoints[right](O,A,B,C)
\end{tikzpicture}
```

### 17.2.3. Orthogonal through

Orthogonal circle passing through two given points.




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(1,0){A}
  \tkzDrawCircle(O,A)
  \tkzDefPoint(-1.5,-1.5){z1}
  \tkzDefPoint(1.5,-1.25){z2}
  \tkzDefCircle[orthogonal through=z1 and z2](O,A)
   \tkzGetPoint{c}
  \tkzDrawCircle[new](tkzPointResult,z1)
  \tkzDrawPoints[new](O,A,z1,z2,c)
  \tkzLabelPoints[right](O,A,z1,z2,c)
\end{tikzpicture}
```

### 17.3. Definition of circle by transformation; \tkzDefCircleBy

These transformations are:

- translation;
- homothety;
- orthogonal reflection or symmetry;
- central symmetry;
- orthogonal projection;
- rotation (degrees);
- inversion.

The choice of transformations is made through the options. The macro is `\tkzDefCircleBy` and the other for the transformation of a list of points `\tkzDefCirclesBy`. For example, we'll write:

```
\tkzDefCircleBy[translation= from A to A'](O,M)
```

O is the center and M is a point on the circle. The image is a circle. The new center is `tkzFirstPointResult` and `tkzSecondPointResult` is a point on the new circle. You can get the results with the macro `\tkzGetPoints`.

`\tkzDefCircleBy[⟨local options⟩](⟨pt1,pt2⟩)`

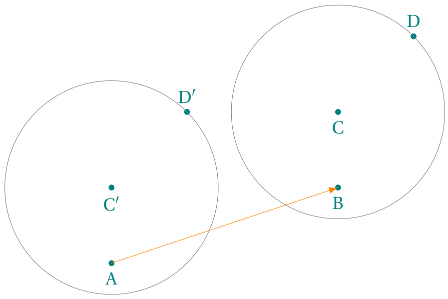
The argument is a couple of points. The results is a couple of points. If you want to keep these points then the macro `\tkzGetPoints{O'}{M'}` allows you to assign the name `O'` to the center and `M'` to the point on the circle.

| arguments | definition | examples |
|---|---|---|
| pt1,pt2 | existing points | (O,M) |

| options | | examples |
|---|---|---|
| translation | = from #1 to #2 | [translation=from A to B](O,M) |
| homothety | = center #1 ratio #2 | [homothety=center A ratio .5](O,M) |
| reflection | = over #1--#2 | [reflection=over A--B](O,M) |
| symmetry | = center #1 | [symmetry=center A](O,M) |
| projection | = onto #1--#2 | [projection=onto A--B](O,M) |
| rotation | = center #1 angle #2 | [rotation=center O angle 30](O,M) |
| inversion | = center #1 through #2 | [inversion =center O through A](O,M) |

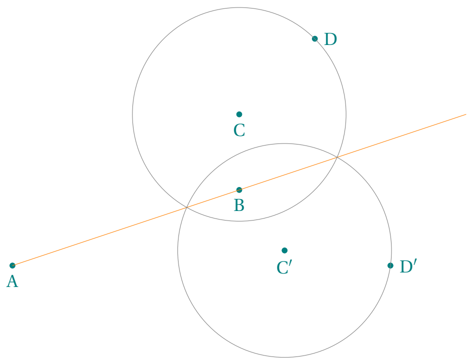
*The image is only defined and not drawn.*

### 17.3.1. Translation



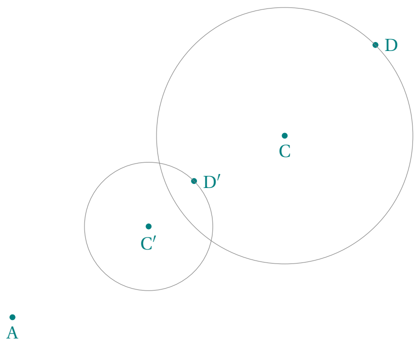

```
\begin{tikzpicture}[>=latex]
 \tkzDefPoint(0,0){A}  \tkzDefPoint(3,1){B}
 \tkzDefPoint(3,2){C}   \tkzDefPoint(4,3){D}
 \tkzDefCircleBy[translation= from B to A](C,D)
 \tkzGetPoints{C'}{D'}
 \tkzDrawPoints[teal](A,B,C,D,C',D')
 \tkzDrawSegments[orange,->](A,B)
 \tkzDrawCircles(C,D C',D')
 \tkzLabelPoints[color=teal](A,B,C,C')
 \tkzLabelPoints[color=teal,above](D,D')
\end{tikzpicture}
```

### 17.3.2. Reflection (orthogonal symmetry)



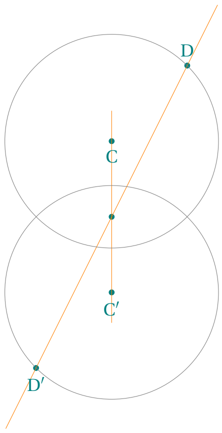

```
\begin{tikzpicture}[>=latex]
 \tkzDefPoint(0,0){A}  \tkzDefPoint(3,1){B}
 \tkzDefPoint(3,2){C}   \tkzDefPoint(4,3){D}
 \tkzDefCircleBy[reflection = over A--B](C,D)
 \tkzGetPoints{C'}{D'}
 \tkzDrawPoints[teal](A,B,C,D,C',D')
 \tkzDrawLine[add =0 and 1][orange](A,B)
 \tkzDrawCircles(C,D C',D')
 \tkzLabelPoints[color=teal](A,B,C,C')
 \tkzLabelPoints[color=teal,right](D,D')
\end{tikzpicture}
```

### 17.3.3. Homothety



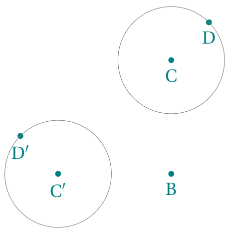

```
\begin{tikzpicture}[scale=1.2]
 \tkzDefPoint(0,0){A}   \tkzDefPoint(3,1){B}
 \tkzDefPoint(3,2){C}   \tkzDefPoint(4,3){D}
 \tkzDefCircleBy[homothety=center A ratio .5](C,D)
 \tkzGetPoints{C'}{D'}
 \tkzDrawPoints[teal](A,C,D,C',D')
 \tkzDrawCircles(C,D C',D')
 \tkzLabelPoints[color=teal](A,C,C')
 \tkzLabelPoints[color=teal,right](D,D')
\end{tikzpicture}
```

#### 17.3.4. Symmetry



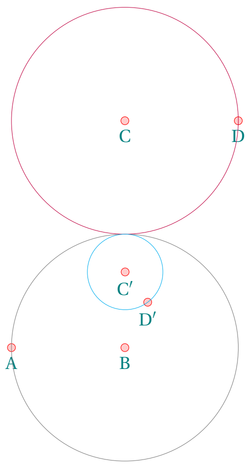

```
\begin{tikzpicture}[scale=1]
 \tkzDefPoint(3,1){B}
 \tkzDefPoint(3,2){C}   \tkzDefPoint(4,3){D}
 \tkzDefCircleBy[symmetry=center B](C,D)
 \tkzGetPoints{C'}{D'}
 \tkzDrawPoints[teal](B,C,D,C',D')
 \tkzDrawLines[orange](C,C' D,D')
 \tkzDrawCircles(C,D C',D')
 \tkzLabelPoints[color=teal](C,C')
 \tkzLabelPoints[color=teal,above](D)
 \tkzLabelPoints[color=teal,below](D')
\end{tikzpicture}
```

#### 17.3.5. Rotation




```
\begin{tikzpicture}[scale=0.5]
 \tkzDefPoint(3,-1){B}
 \tkzDefPoint(3,2){C}   \tkzDefPoint(4,3){D}
 \tkzDefCircleBy[rotation=center B angle 90](C,D)
 \tkzGetPoints{C'}{D'}
 \tkzDrawPoints[teal](B,C,D,C',D')
 \tkzLabelPoints[color=teal](B,C,D,C',D')
 \tkzDrawCircles(C,D C',D')
\end{tikzpicture}
```

#### 17.3.6. Inversion




```
\begin{tikzpicture}[scale=1.5]
\tkzSetUpPoint[size=3,color=red,fill=red!20]
\tkzSetUpStyle[color=purple,ultra thin]{st1}
\tkzSetUpStyle[color=cyan,ultra thin]{st2}
\tkzDefPoint(2,0){A} \tkzDefPoint(3,0){B}
\tkzDefPoint(3,2){C} \tkzDefPoint(4,2){D}
\tkzDefCircleBy[inversion = center B through A](C,D)
\tkzGetPoints{C'}{D'}
\tkzDrawPoints(A,B,C,D,C',D')
\tkzLabelPoints(A,B,C,D,C',D')
\tkzDrawCircles(B,A)
\tkzDrawCircles[st1](C,D)
\tkzDrawCircles[st2](C',D')
\end{tikzpicture}
```

## 18. Intersections

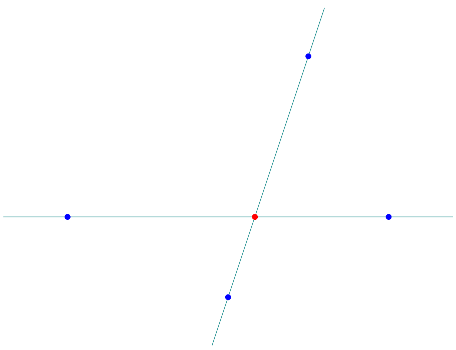
It is possible to determine the coordinates of the points of intersection between two straight lines, a straight line and a circle, and two circles.
The associated commands have no optional arguments and the user must determine the existence of the intersection points himself.

## 18.1. Intersection of two straight lines \tkzInterLL

`\tkzInterLL(⟨A,B⟩)(⟨C,D⟩)`

Defines the intersection point `tkzPointResult` of the two lines (AB) and (CD). The known points are given in pairs (two per line) in brackets, and the resulting point can be retrieved with the macro `\tkzDefPoint`.

### 18.1.1. Example of intersection between two straight lines



```
\begin{tikzpicture}[rotate=-45,scale=.75]
  \tkzDefPoint(2,1){A}
  \tkzDefPoint(6,5){B}
  \tkzDefPoint(3,6){C}
  \tkzDefPoint(5,2){D}
  \tkzDrawLines(A,B C,D)
  \tkzInterLL(A,B)(C,D)
     \tkzGetPoint{I}
  \tkzDrawPoints[color=blue](A,B,C,D)
   \tkzDrawPoint[color=red](I)
\end{tikzpicture}
```

## 18.2. Intersection of a straight line and a circle \tkzInterLC

As before, the line is defined by a couple of points. The circle is also defined by a couple:

- (O, C) which is a pair of points, the first is the center and the second is any point on the circle.
- (O, r) The r measure is the radius measure.

`\tkzInterLC[⟨options⟩](⟨A,B⟩)(⟨O,C⟩) or (⟨O,r⟩) or (⟨O,C,D⟩)`

So the arguments are two couples.

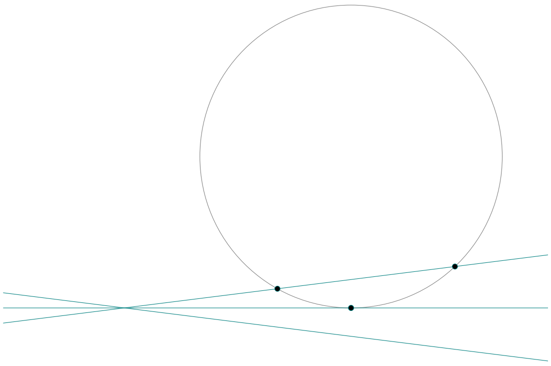
| options | default | definition |
|---|---|---|
| N | N | (O,C) determines the circle |
| R | N | (O, 1 ) unit 1 cm |
| with nodes | N | (O,C,D) CD is a radius |
| common=pt | | pt is common point; tkzFirstPoint gives the other point |
| near | | tkzFirstPoint is the closest point to the first point of the line |

The macro defines the intersection points I and J of the line (AB) and the center circle O with radius r if they exist; otherwise, an error will be reported in the `.log` file. `with nodes` avoids you to calculate the radius which is the length of [CD]. If `common` and `near` are not used then `tkzFirstPoint` is the smallest angle (angle with `tkzSecondPoint` and the center of the circle).

`\tkzTestInterLC(⟨O,A⟩)(⟨O′,B⟩)`

So the arguments are two couples which define a line and a circle with a center and a point on the circle. If there is a non empty intersection between these the line and the circle then the test `\iftkzFlagLC` gives true.

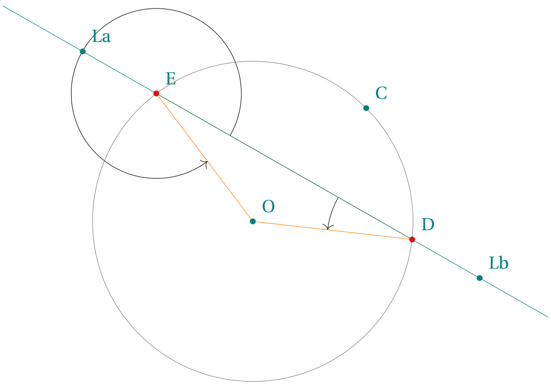
### 18.2.1. test line-circle intersection



```
\begin{tikzpicture}[scale=1]
  \tkzDefPoints{% x   y   name
                 3   /4   /I,
                 3   /2   /P,
                 0   /2   /La,
                 8   /3   /Lb}
\tkzDrawCircle(I,P)
\foreach \i in {1,...,3}{%
   \coordinate  (Lb) at (8,\i);
   \tkzDrawLine(La,Lb)
   \tkzTestInterLC(La,Lb)(I,P)
    \iftkzFlagLC
    \tkzInterLC(La,Lb)(I,P)
    \tkzGetPoints{a}{b}
    \tkzDrawPoints(a,b)
    \fi
   }
\end{tikzpicture}
```

### 18.2.2. Line-circle intersection

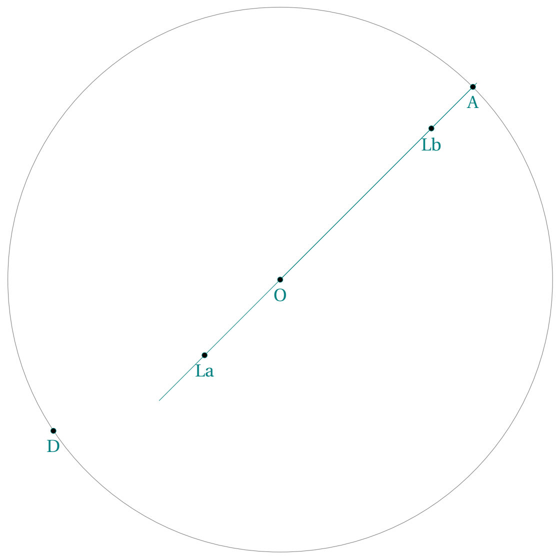
In the following example, the drawing of the circle uses two points and the intersection of the straight line and the circle uses two pairs of points. We will compare the angles $\widehat{D,E,O}$ and $\widehat{E,D,O}$. These angles are in opposite directions. **tkzFirstPoint** is assigned to the point that forms the angle with the smallest measure (counterclockwise direction). The counterclockwide angle $\widehat{D,E,O}$ has a measure equal to 360∘ minus the measure of $\widehat{O,E,D}$.




```
\begin{tikzpicture}[scale=.75]
 \tkzInit[xmax=5,ymax=4]
 \tkzDefPoint(1,1){O}
 \tkzDefPoint(-2,4){La}
 \tkzDefPoint(5,0){Lb}
 \tkzDefPoint(3,3){C}
 \tkzInterLC(La,Lb)(O,C)  \tkzGetPoints{D}{E}
 \tkzMarkAngle[->,size=1.5](E,D,O)
 \tkzDrawPolygons[new](O,D,E)
 \tkzMarkAngle[->,size=1.5](D,E,O)
 \tkzDrawCircle(O,C)
 \tkzDrawPoints[color=teal](O,La,Lb,C)
 \tkzDrawPoints[color=red](D,E)
 \tkzDrawLine(La,Lb)
 \tkzLabelPoints[above right](O,La,Lb,C,D,E)
\end{tikzpicture}
```

### 18.2.3. Line passing through the center option common

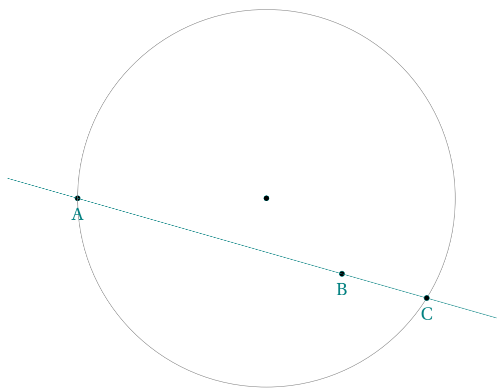
This case is special. You cannot compare the angles. In this case, the option **near** must be used. **tkzFirstPoint** is assigned to the point closest to the first point given for the line. Here we want A to be closest to Lb.




```
\begin{tikzpicture}
\tkzDefPoints{% x    y    name
              0    /1    /D,
              6    /0    /B,
              3    /3    /O,
              2    /2    /La,
              5    /5    /Lb}
  \tkzDrawCircle(O,D)
  \tkzDrawLine(La,Lb)
  \tkzInterLC[near](Lb,La)(O,D)
  \tkzGetFirstPoint{A}
  \tkzDrawSegments(O,A)
  \tkzDrawPoints(O,D,A,La,Lb)
  \tkzLabelPoints(O,D,A,La,Lb)
\end{tikzpicture}
```

### 18.2.4. Line-circle intersection with option `common`

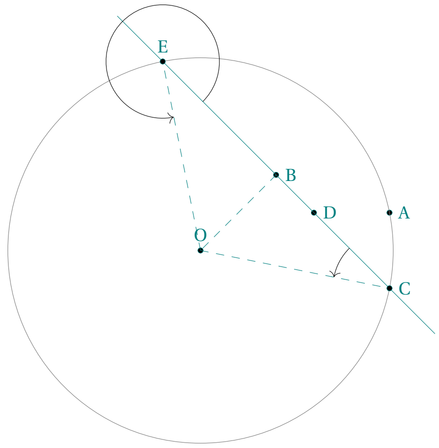
A special case that we often meet, a point of the line is on the circle and we are looking for the other common point.




```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoints{0/0/O,-5/0/A,2/-2/B,0/5/D}
 \tkzInterLC[common=A](B,A)(O,D)
 \tkzGetFirstPoint{C}
 \tkzDrawPoints(O,A,B)
 \tkzDrawCircle(O,A)
 \tkzDrawLine(A,C)
 \tkzDrawPoint(C)
 \tkzLabelPoints(A,B,C)
\end{tikzpicture}
```

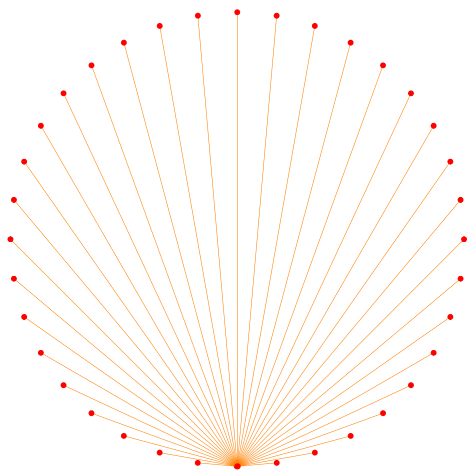
### 18.2.5. Line-circle intersection order of points

The idea is to compare the angles formed with the first defining point of the line, a resultant point and the center of the circle. The first point is the one that corresponds to the smallest angle.
As you can see $\widehat{BCO} < \widehat{BEO}$. To tell the truth,$\widehat{BEO}$ is counterclockwise.




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{0/0/O,5/1/A,2/2/B,3/1/D}
  \tkzInterLC[common=A](B,D)(O,A) \tkzGetPoints{C}{E}
  \tkzDrawPoints(O,A,B,D)
  \tkzDrawCircle(O,A) \tkzDrawLine(E,C)
  \tkzDrawSegments[dashed](B,O O,C)
  \tkzMarkAngle[->,size=1.5](B,C,O)
  \tkzDrawSegments[dashed](O,E)
  \tkzMarkAngle[->,size=1.5](B,E,O)
  \tkzDrawPoints(C,E)
  \tkzLabelPoints[above](O,E)
  \tkzLabelPoints[right](A,B,C,D)
\end{tikzpicture}
```

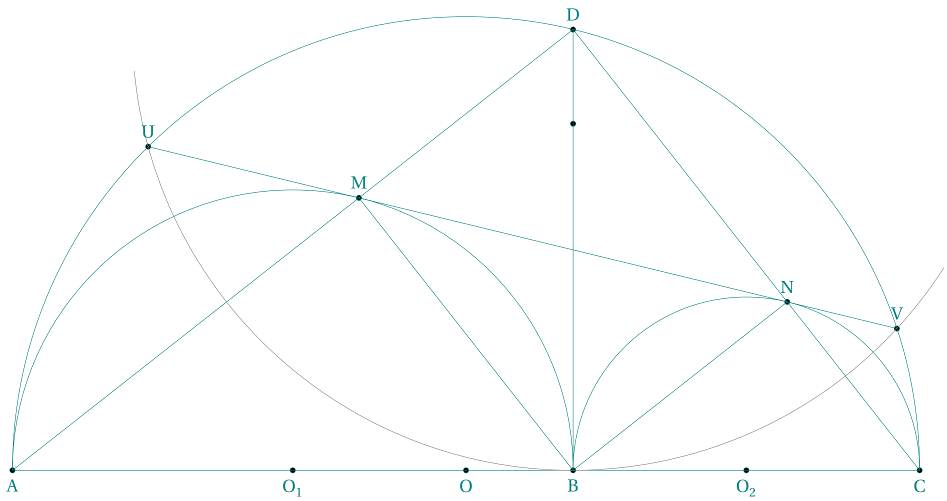
### 18.2.6. Example with \foreach



```
\begin{tikzpicture}[scale=3,rotate=180]
\tkzDefPoint(0,1){J}
\tkzDefPoint(0,0){O}
\foreach \i in {0,-5,-10,...,-90}{
 \tkzDefPoint({2.5*cos(\i*pi/180)},%
   {1+2.5*sin(\i*pi/180)}){P}
 \tkzInterLC[R](P,J)(O,1)\tkzGetPoints{N}{M}
 \tkzDrawSegment[color=orange](J,N)
 \tkzDrawPoints[red](N)}
\foreach \i in {-90,-95,...,-175,-180}{
 \tkzDefPoint({2.5*cos(\i*pi/180)},%
   {1+2.5*sin(\i*pi/180)}){P}
 \tkzInterLC[R](P,J)(O,1)\tkzGetPoints{N}{M}
 \tkzDrawSegment[color=orange](J,M)
 \tkzDrawPoints[red](M)}
\end{tikzpicture}
```

### 18.2.7. Line-circle intersection with option near

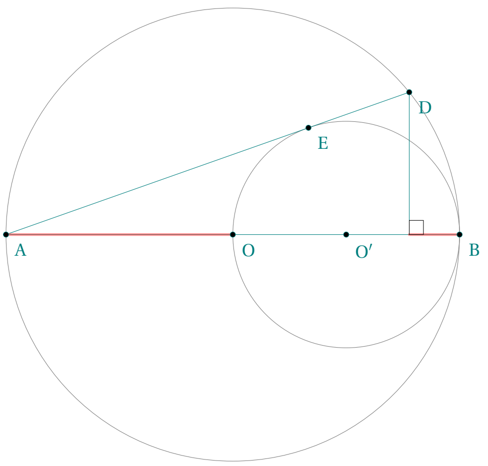
D is the point closest to b.



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,12/0/C}
  \tkzDefGoldenRatio(A,C)                           \tkzGetPoint{B}
  \tkzDefMidPoint(A,C)                              \tkzGetPoint{O}
  \tkzDefMidPoint(A,B)                              \tkzGetPoint{O_1}
  \tkzDefMidPoint(B,C)                              \tkzGetPoint{O_2}
  \tkzDefPointBy[rotation=center O_2 angle 90](C)  \tkzGetPoint{P}
  \tkzDefPointBy[rotation=center O_1 angle 90](B)  \tkzGetPoint{Q}
  \tkzDefPointBy[rotation=center B angle 90](C)    \tkzGetPoint{b}
  \tkzInterLC[near](b,B)(O,A)                       \tkzGetFirstPoint{D}
  \tkzInterCC(D,B)(O,C)                             \tkzGetPoints{V}{U}
  \tkzDefPointBy[projection=onto U--V](O_1)         \tkzGetPoint{M}
  \tkzDefPointBy[projection=onto U--V](O_2)         \tkzGetPoint{N}
  \tkzDrawPoints(A,B,C,O,O_1,O_2,D,U,V,M,N,b)
  \tkzDrawSemiCircles[teal](O,C O_1,B O_2,C)
  \tkzDrawSegments(A,C B,D U,V A,D C,D M,B B,N)
  \tkzDrawArc(D,U)(V)
  \tkzLabelPoints(A,B,C,O,O_1,O_2)
  \tkzLabelPoints[above](D,U,V,M,N)
\end{tikzpicture}
```

### 18.2.8. More complex example of a line-circle intersection

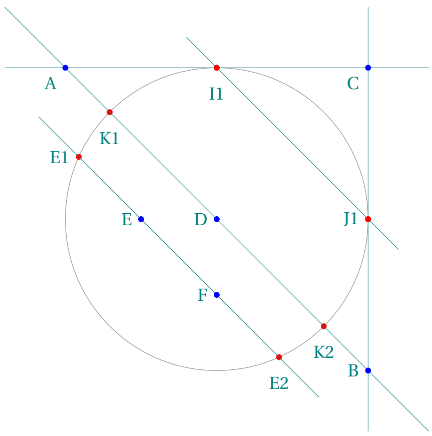
Figure from http://gogeometry.com/problem/p190_tangent_circle




```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoint(0,0){A}
 \tkzDefPoint(8,0){B}
 \tkzDefMidPoint(A,B)              \tkzGetPoint{O}
 \tkzDefMidPoint(O,B)              \tkzGetPoint{O'}
 \tkzDefLine[tangent from=A](O',B)\tkzGetFirstPoint{E}
 \tkzInterLC(A,E)(O,B)             \tkzGetFirstPoint{D}
 \tkzDefPointBy[projection=onto A--B](D)
 \tkzGetPoint{F}
 \tkzDrawCircles(O,B O',B)
 \tkzDrawSegments(A,D A,B D,F)
 \tkzDrawSegments[color=red,line width=1pt,
     opacity=.4](A,O F,B)
 \tkzDrawPoints(A,B,O,O',E,D)
 \tkzMarkRightAngle(D,F,B)
 \tkzLabelPoints[below right](A,B,O,O',E,D)
\end{tikzpicture}
```

### 18.2.9. Circle defined by a center and a measure, and special cases

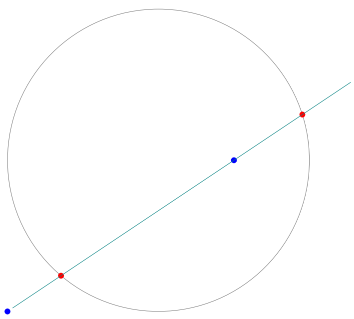
Let's look at some special cases like straight lines tangent to the circle.




```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoint(0,8){A}      \tkzDefPoint(8,0){B}
 \tkzDefPoint(8,8){C}      \tkzDefPoint(4,4){D}
 \tkzDefPoint(2,4){E}      \tkzDefPoint(4,2){F}
 \tkzDefPoint(8,4){G}
 \tkzInterLC(A,C)(D,G)     \tkzGetPoints{I1}{I2}
 \tkzInterLC(B,C)(D,G)     \tkzGetPoints{J1}{J2}
 \tkzInterLC[near](A,B)(D,G)  \tkzGetPoints{K1}{K2}
 \tkzInterLC(E,F)(D,G)     \tkzGetPoints{E1}{E2}
 \tkzDrawCircle(D,G)
 \tkzDrawPoints[color=red](I1,J1,K1,K2,E1,E2)
 \tkzDrawLines(A,B B,C A,C I2,J2 E1,E2)
 \tkzDrawPoints[color=blue](A,...,F)
 \tkzDrawPoints[color=red](I2,J2)
 \tkzLabelPoints[left](B,D,E,F)
 \tkzLabelPoints[below left](A,C)
 \tkzLabelPoints[below=4pt](I1,K1,K2,E2)
 \tkzLabelPoints[left](J1,E1)
\end{tikzpicture}
```

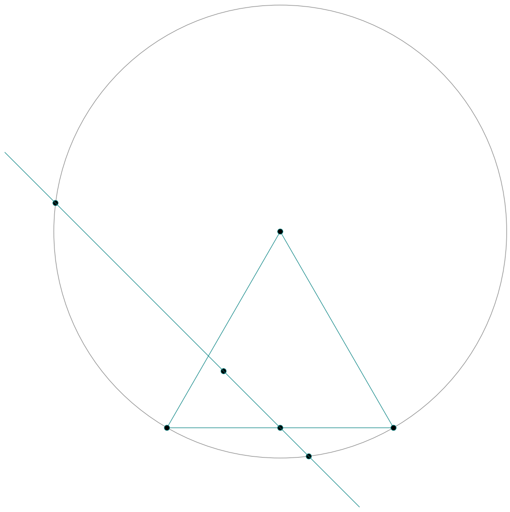
### 18.2.10. Calculation of radius

With **pgfmath** and `\pgfmathsetmacro`
The radius measurement may be the result of a calculation that is not done within the intersection macro, but before. A length can be calculated in several ways. It is possible of course, to use the module **pgfmath** and the macro `\pgfmathsetmacro`. In some cases, the results obtained are not precise enough, so the following calculation $0.0002 \div 0.0001$ gives 1.98 with pgfmath while xfp will give 2.
With **xfp** and `\fpeval`:



```
 \begin{tikzpicture}
 \tkzDefPoint(2,2){A}
 \tkzDefPoint(5,4){B}
 \tkzDefPoint(4,4){O}
 \pgfmathsetmacro\tkzLen{\fpeval{0.0002/0.0001}}
% or \edef\tkzLen{\fpeval{0.0002/0.0001}}
 \tkzInterLC[R](A,B)(O, \tkzLen)
 \tkzGetPoints{I}{J}
 \tkzDrawCircle(O,I)
 \tkzDrawPoints[color=blue](A,B)
 \tkzDrawPoints[color=red](I,J)
 \tkzDrawLine(I,J)
\end{tikzpicture}
```

### 18.2.11. Option with nodes



```
\begin{tikzpicture}[scale=.75]
\tkzDefPoints{0/0/A,4/0/B,1/1/D,2/0/E}
\tkzDefTriangle[equilateral](A,B)
\tkzGetPoint{C}
\tkzInterLC[with nodes](D,E)(C,A,B)
\tkzGetPoints{F}{G}
\tkzDrawCircle(C,A)
\tkzDrawPolygon(A,B,C)
\tkzDrawPoints(A,...,G)
\tkzDrawLine(F,G)
\end{tikzpicture}
```

## 18.3. Intersection of two circles \tkzInterCC

The most frequent case is that of two circles defined by their center and a point, but as before the option `R` allows to use the radius measurements.

`\tkzInterCC[⟨options⟩](⟨O,A⟩)(⟨O',A'⟩) or (⟨O,r⟩)(⟨O',r'⟩) or (⟨O,A,B⟩) (⟨O',C,D⟩)`

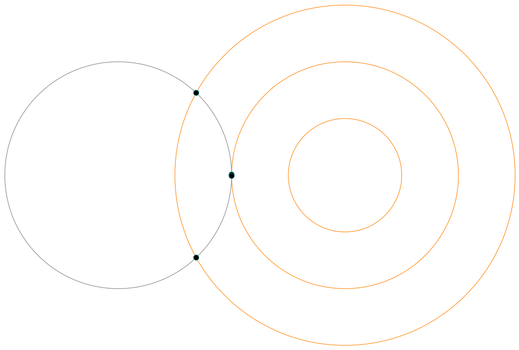
| options | default | definition |
|---|---|---|
| N | N | OA and O′A′ are radii, O and O′ are the centers. |
| R | N | r and r′ are dimensions and measure the radii. |
| with nodes | N | in (A,A,C)(C,B,F) AC and BF give the radii. |
| common=pt | | pt is common point; tkzFirstPoint gives the other point. |

This macro defines the intersection point(s) I and J of the two center circles O and O′. If the two circles do not have a common point then the macro ends with an error that is not handled. If the centers are O and O′ and the intersections are A and B then the angles $\widehat{O,A,O'}$ and $\widehat{O,B,O'}$ are in opposite directions. **tkzFirstPoint** is assigned to the point that forms the `clockwise` angle.

`\tkzTestInterCC(⟨O,A⟩)(⟨O',B⟩)`

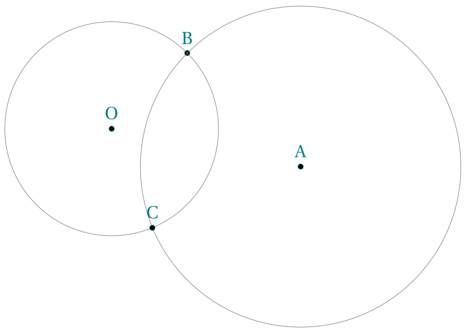
So the arguments are two couples which define two circles with a center and a point on the circle. If there is a non empty intersection between these two circles then the test `\iftkzFlagCC` gives true.

### 18.3.1. test circle-circle intersection



```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{% x    y    name
                 0    /0    /A,
                 2    /0    /B,
                 4    /0    /I,
                 1    /0    /P}
\tkzDrawCircle(A,B)
\foreach \i in {1,...,3}{%
   \coordinate  (P) at (\i,0);
\tkzDrawCircle[new](I,P)
   \tkzTestInterCC(A,B)(I,P)
    \iftkzFlagCC
    \tkzInterCC(A,B)(I,P)  \tkzGetPoints{a}{b}
    \tkzDrawPoints(a,b)
    \fi}
  \end{tikzpicture}
```

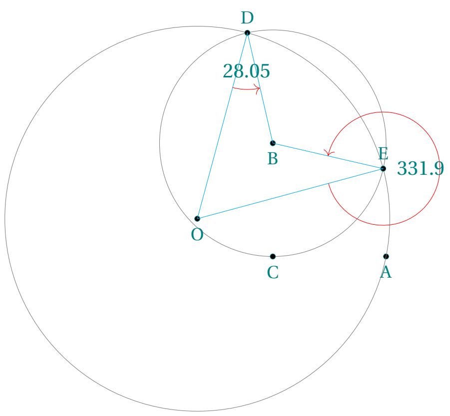
### 18.3.2. circle-circle intersection with common point.




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{0/0/O,5/-1/A,2/2/B}
  \tkzDrawPoints(O,A,B)
  \tkzDrawCircles(O,B A,B)
  \tkzInterCC[common=B](O,B)(A,B)
  \tkzGetFirstPoint{C}
  \tkzDrawPoint(C)
  \tkzLabelPoints[above](O,A,B,C)
\end{tikzpicture}
```

### 18.3.3. circle-circle intersection order of points.

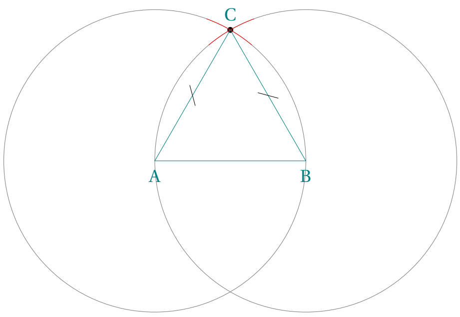
The idea is to compare the angles formed with the first center, a resultant point and the center of the second circle. The first point is the one that corresponds to the smallest angle.
As you can see $\widehat{ODB} < \widehat{OBE}$




```
\begin{tikzpicture}[scale=.5]
  \pgfkeys{/pgf/number format/.cd,fixed relative,
     precision=4}
  \tkzDefPoints{0/0/O,5/-1/A,2/2/B,2/-1/C}
  \tkzDrawPoints(O,A,B)
  \tkzDrawCircles(O,A B,C)
  \tkzInterCC(O,A)(B,C)\tkzGetPoints{D}{E}
  \tkzDrawPoints(C,D,E)
  \tkzLabelPoints(O,A,B,C)
  \tkzLabelPoints[above](D,E)
  \tkzDrawSegments[cyan](D,O D,B)
  \tkzMarkAngle[red,->,size=1.5](O,D,B)
  \tkzFindAngle(O,D,B)   \tkzGetAngle{an}
  \tkzLabelAngle(O,D,B){$ \pgfmathprintnumber{\an}$}
  \tkzDrawSegments[cyan](E,O E,B)
  \tkzMarkAngle[red,->,size=1.5](O,E,B)
  \tkzFindAngle(O,E,B)   \tkzGetAngle{an}
  \tkzLabelAngle(O,E,B){$ \pgfmathprintnumber{\an}$}
\end{tikzpicture}
```

### 18.3.4. Construction of an equilateral triangle.

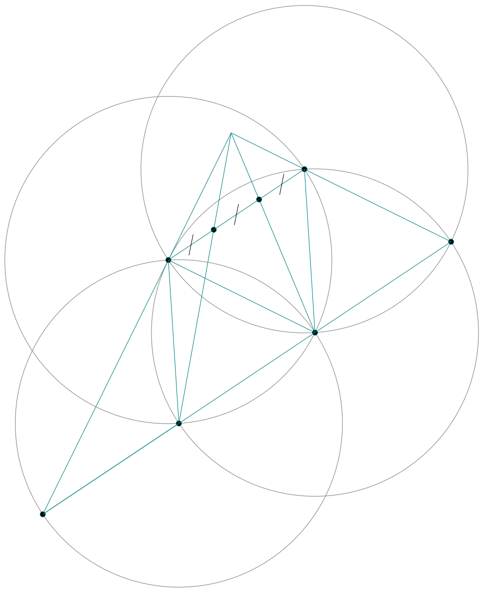
$\widehat{A,C,B}$ is a clockwise angle




```
\begin{tikzpicture}[trim left=-1cm,scale=.5]
 \tkzDefPoint(1,1){A}
 \tkzDefPoint(5,1){B}
 \tkzInterCC(A,B)(B,A)\tkzGetPoints{C}{D}
 \tkzDrawPoint[color=black](C)
 \tkzDrawCircles(A,B B,A)
 \tkzCompass[color=red](A,C)
 \tkzCompass[color=red](B,C)
 \tkzDrawPolygon(A,B,C)
 \tkzMarkSegments[mark=s|](A,C B,C)
 \tkzLabelPoints[](A,B)
 \tkzLabelPoint[above](C){$C$}
\end{tikzpicture}
```

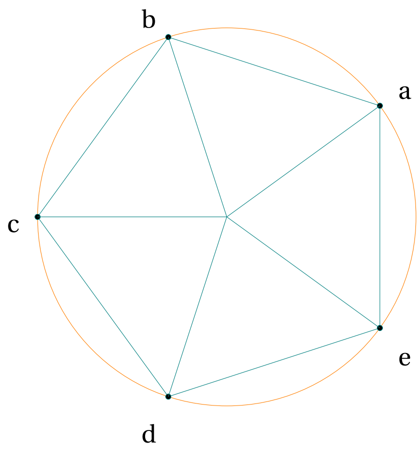
### 18.3.5. Segment trisection

The idea here is to divide a segment with a ruler and a compass into three segments of equal length.



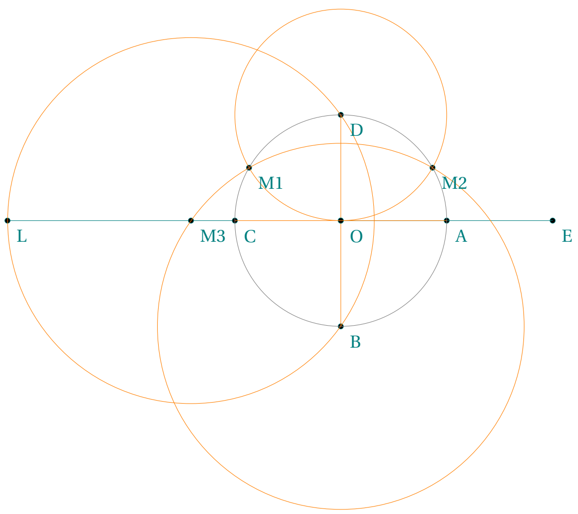
```
\begin{tikzpicture}[scale=.6]
 \tkzDefPoint(0,0){A}
 \tkzDefPoint(3,2){B}
 \tkzInterCC(A,B)(B,A)           \tkzGetSecondPoint{D}
 \tkzInterCC(D,B)(B,A)           \tkzGetPoints{A}{C}
 \tkzInterCC(D,B)(A,B)           \tkzGetPoints{E}{B}
 \tkzInterLC[common=D](C,D)(E,D)\tkzGetFirstPoint{F}
 \tkzInterLL(A,F)(B,C)           \tkzGetPoint{O}
 \tkzInterLL(O,D)(A,B)           \tkzGetPoint{H}
 \tkzInterLL(O,E)(A,B)           \tkzGetPoint{G}
 \tkzDrawCircles(D,E A,B B,A E,A)
 \tkzDrawSegments[](O,F O,B O,D O,E)
 \tkzDrawPoints(A,...,H)
 \tkzDrawSegments(A,B B,D A,D A,E E,F C,F B,C)
 \tkzMarkSegments[mark=s|](A,G G,H H,B)
\end{tikzpicture}
```

### 18.3.6. With the option with nodes




```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoints{0/0/A,0/5/B,5/0/C}
 \tkzDefPoint(54:5){F}
 \tkzInterCC[with nodes](A,A,C)(C,B,F)
 \tkzGetPoints{a}{e}
 \tkzInterCC(A,C)(a,e) \tkzGetFirstPoint{b}
 \tkzInterCC(A,C)(b,a) \tkzGetFirstPoint{c}
 \tkzInterCC(A,C)(c,b) \tkzGetFirstPoint{d}
 \tkzDrawCircle[new](A,C)
 \tkzDrawPoints(a,b,c,d,e)
 \tkzDrawPolygon(a,b,c,d,e)
 \foreach \vertex/\num in {a/36,b/108,c/180,
                           d/252,e/324}{%
 \tkzDrawPoint(\vertex)
 \tkzLabelPoint[label=\num:$\vertex$](\vertex){}
 \tkzDrawSegment(A,\vertex)
 }
\end{tikzpicture}
```

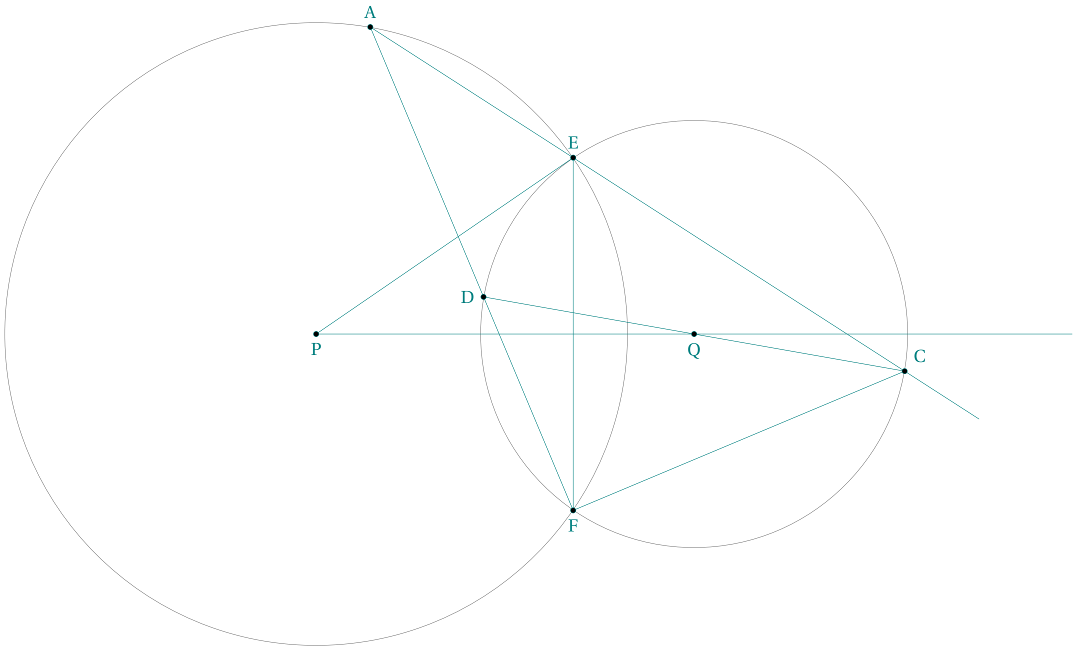
### 18.3.7. Mix of intersections




```
\begin{tikzpicture}[scale = .7]
  \tkzDefPoint(2,2){A}
  \tkzDefPoint(0,0){B}
  \tkzDefPoint(-2,2){C}
  \tkzDefPoint(0,4){D}
  \tkzDefPoint(4,2){E}
  \tkzCircumCenter(A,B,C)\tkzGetPoint{O}
  \tkzInterCC[R](O,2)(D,2)\tkzGetPoints{M1}{M2}
  \tkzInterCC(O,A)(D,O) \tkzGetPoints{1}{2}
  \tkzInterLC(A,E)(B,M1)\tkzGetSecondPoint{M3}
  \tkzInterLC(O,C)(M3,D)\tkzGetSecondPoint{L}
  \tkzDrawSegments(C,L)
  \tkzDrawPoints(A,B,C,D,E,M1,M2,M3,O,L)
  \tkzDrawSegments(O,E)
  \tkzDrawSegments[new](C,A D,B)
  \tkzDrawPoint(O)
  \tkzDrawCircles[new](M3,D B,M2 D,O)
  \tkzDrawCircle(O,A)
  \tkzLabelPoints[below right](A,B,C,D,E,M1,M2,M3,O,L)
\end{tikzpicture}
```

### 18.3.8. Altshiller-Court's theorem

The two lines joining the points of intersection of two orthogonal circles to a point on one of the circles met the other circle in two diametricaly oposite points. Altshiller p 176

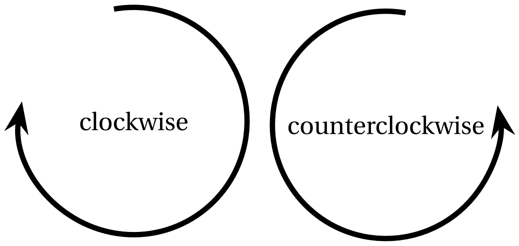



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/P,5/0/Q,3/2/I}
  \tkzDefCircle[orthogonal from=P](Q,I)
  \tkzGetFirstPoint{E}
  \tkzDrawCircles(P,E Q,E)
  \tkzInterCC[common=E](P,E)(Q,E) \tkzGetFirstPoint{F}
  \tkzDefPointOnCircle[through =  center P angle 80 point E]
  \tkzGetPoint{A}
  \tkzInterLC[common=E](A,E)(Q,E)  \tkzGetFirstPoint{C}
  \tkzInterLL(A,F)(C,Q)  \tkzGetPoint{D}
  \tkzDrawLines[add=0 and 1](P,Q)
  \tkzDrawLines[add=0 and 2](A,E)
  \tkzDrawSegments(P,E E,F F,C A,F C,D)
  \tkzDrawPoints(P,Q,E,F,A,C,D)
  \tkzLabelPoints(P,Q,F)
  \tkzLabelPoints[above](E,A)
  \tkzLabelPoints[left](D)
  \tkzLabelPoints[above right](C)
\end{tikzpicture}
```

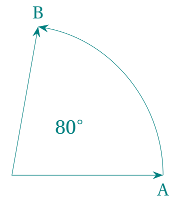
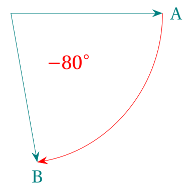
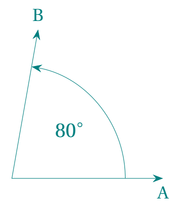
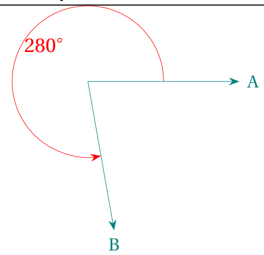
# 19. Angles

## 19.1. Definition and usage with tkz-euclide

In Euclidean geometry, an angle is the figure formed by two rays, called the sides of the angle, sharing a common endpoint, called the vertex of the angle.[Wikipedia]. A ray with **tkz-euclide** is defined by two points also each angle is defined with three points like $\widehat{AOB}$. The vertex O is the second point. Their order is important because it is assumed that the angle is specified in the direct order (counterclockwise). In trigonometry and mathematics in general, plane angles are conventionally measured counterclockwise, starting with 0° pointing directly to the right (or east), and 90° pointing straight up (or north)[Wikipedia]. Let us agree that an angle measured counterclockwise is positive.




`Angles` are involved in several macros like `\tkzDefPoint`,`\tkzDefPointBy[rotation = …]`, `\tkzDrawArc` and the next one `\tkzGetAngle`. With the exception of the last one, all these macros accept negative angles.

| | |
|---|---|
|   Rotation 80° from (O,A) to (O,B) \tkzDefPointBy[rotation=center O angle 80] |   Rotation −80° from (O,A) to (O,B) \tkzDefPointBy[rotation=center O angle -80] |
|   \tkzFindAngle(A,O,B) gives 80 |   \tkzFindAngle(A,O,B) gives 280° |

As we can see, the −80° rotation defines a clockwise angle but the macro `\tkzFindAngle` recovers a counterclockwise angle.

### 19.2. Recovering an angle `\tkzGetAngle`

`\tkzGetAngle(⟨name of macro⟩)`

Assigns the value in degree of an angle to a macro. The value is positive and between 0° and 360°. This macro retrieves `\tkzAngleResult` and stores the result in a new macro.

| arguments | example | explanation |
|---|---|---|
| `name of macro` | `\tkzGetAngle{ang}` | `\ang contains the value of the angle.` |

This is an auxiliary macro that allows you to retrieve the result of the following macro `\tkzFindAngle`.

### 19.3. Angle formed by three points

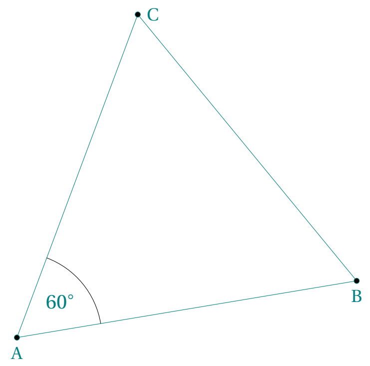
`\tkzFindAngle(⟨pt1,pt2,pt3⟩)`

The result is stored in a macro `\tkzAngleResult`.

| arguments | example | explanation |
|---|---|---|
| `(pt1,pt2,pt3)` | `\tkzFindAngle(A,B,C)` | `\tkzAngleResult gives the angle` $(\overrightarrow{BA},\overrightarrow{BC})$ |

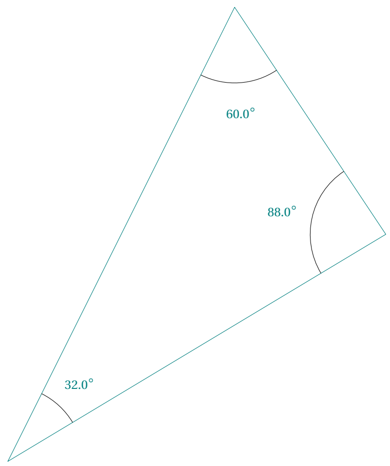
The measure is always positive and between 0° and 360°. With the usual conventions, a counterclockwise angle smaller than a straight angle has always a measure between 0° and 180°, while a clockwise angle smaller than a straight angle will have a measurement greater than 180°. **\tkzGetAngle** can retrieve the angle.

### 19.3.1. Verification of angle measurement




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(-1,1){A}
  \tkzDefPoint(5,2){B}
  \tkzDefEquilateral(A,B)
  \tkzGetPoint{C}
  \tkzDrawPolygon(A,B,C)
  \tkzFindAngle(B,A,C) \tkzGetAngle{angleBAC}
  \edef\angleBAC{\fpeval{round(\angleBAC)}}
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,B)
  \tkzLabelPoint[right](C){$C$}
  \tkzLabelAngle(B,A,C){\angleBAC$^\circ$}
  \tkzMarkAngle[size=1.5](B,A,C)
\end{tikzpicture}
```

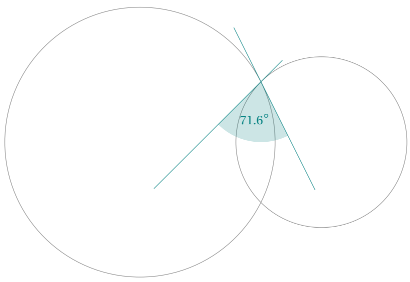
### 19.3.2. Determination of the three angles of a triangle




```
\begin{tikzpicture}
\tikzset{label angle style/.append style={pos=1.4}}
\tkzDefPoints{0/0/a,5/3/b,3/6/c}
\tkzDrawPolygon(a,b,c)
\tkzFindAngle(c,b,a)\tkzGetAngle{angleCBA}
\pgfmathparse{round(1+\angleCBA)}
\let\angleCBA\pgfmathresult
\tkzFindAngle(a,c,b)\tkzGetAngle{angleACB}
\pgfmathparse{round(\angleACB)}
\let\angleACB\pgfmathresult
\tkzFindAngle(b,a,c)\tkzGetAngle{angleBAC}
\pgfmathparse{round(\angleBAC)}
\let\angleBAC\pgfmathresult
\tkzMarkAngle(c,b,a)
\tkzLabelAngle(c,b,a){\tiny $\angleCBA^\circ$}
\tkzMarkAngle(a,c,b)
\tkzLabelAngle(a,c,b){\tiny $\angleACB^\circ$}
\tkzMarkAngle(b,a,c)
\tkzLabelAngle(b,a,c){\tiny $\angleBAC^\circ$}
\end{tikzpicture}
```

### 19.3.3. Angle between two circles

We are looking for the angle formed by the tangents at a point of intersection




```
\begin{tikzpicture}[scale=.4]
\pgfkeys{/pgf/number format/.cd,%
          fixed,precision=1}
\tkzDefPoints{0/0/A,6/0/B,4/2/C}
\tkzDrawCircles(A,C B,C)
\tkzDefLine[tangent at=C](A) \tkzGetPoint{a}
\tkzDefPointsBy[symmetry = center C](a){d}
\tkzDefLine[tangent at=C](B) \tkzGetPoint{b}
\tkzDrawLines[add=1 and 4](a,C  C,b)
\tkzFillAngle[fill=teal,opacity=.2%
                         ,size=2](b,C,d)
\tkzFindAngle(b,C,d)\tkzGetAngle{bcd}
\tkzLabelAngle[pos=1.25](b,C,d){%
  \tiny $\pgfmathprintnumber{\bcd}^\circ$}
\end{tikzpicture}
```

## 19.4. Angle formed by a straight line with the horizontal axis \tkzFindSlopeAngle

Much more interesting than the last one. The result is between -180 degrees and +180 degrees.

**\tkzFindSlopeAngle(⟨A,B⟩)**

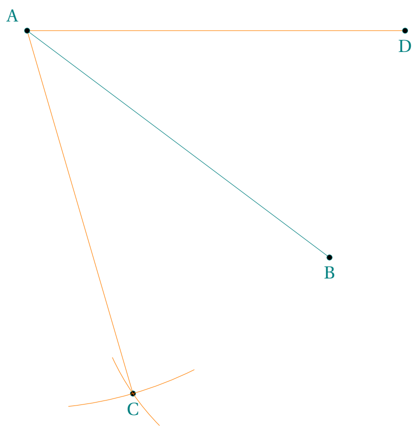
Determines the slope of the straight line (AB). The result is stored in a macro **\tkzAngleResult**.

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2) | **\tkzFindSlopeAngle**(A,B) | |

**\tkzGetAngle** can retrieve the result. If retrieval is not necessary, you can use **\tkzAngleResult**.

### 19.4.1. How to use \tkzFindSlopeAngle

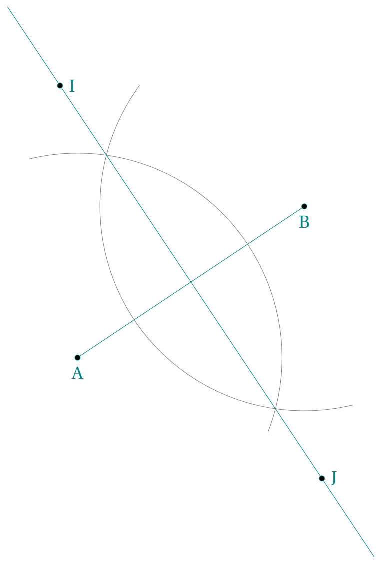
The point here is that (AB) is the bisector of $\widehat{CAD}$, such that the AD slope is zero. We recover the slope of (AB) and then rotate twice.




```
\begin{tikzpicture}
 \tkzDefPoint(1,5){A} \tkzDefPoint(5,2){B}
 \tkzFindSlopeAngle(A,B)\tkzGetAngle{tkzang}
 \tkzDefPointBy[rotation= center A angle \tkzang ](B)
 \tkzGetPoint{C}
 \tkzDefPointBy[rotation= center A angle -\tkzang ](B)
 \tkzGetPoint{D}
 \tkzDrawSegment(A,B)
 \tkzDrawSegments[new](A,C A,D)
 \tkzDrawPoints(A,B,C,D)
 \tkzCompass[length=1](A,C)
 \tkzCompass[delta=10,brown](B,C)
 \tkzLabelPoints(B,C,D)
 \tkzLabelPoints[above left](A)
\end{tikzpicture}
```

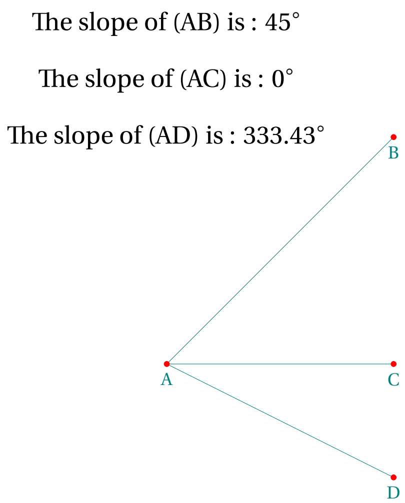
### 19.4.2. Use of \tkzFindSlopeAngle and \tkzGetAngle

Here is another version of the construction of a mediator




```
\begin{tikzpicture}
 \tkzInit
 \tkzDefPoint(0,0){A}          \tkzDefPoint(3,2){B}
 \tkzDefLine[mediator](A,B)   \tkzGetPoints{I}{J}
 \tkzCalcLength(A,B)          \tkzGetLength{dAB}
 \tkzFindSlopeAngle(A,B)      \tkzGetAngle{tkzangle}
 \begin{scope}[rotate=\tkzangle]
   \tkzSetUpArc[color=gray,line width=0.2pt,%
     /tkzcompass/delta=10]
   \tkzDrawArc[R,arc](B,3/4*\dAB)(120,240)
   \tkzDrawArc[R,arc](A,3/4*\dAB)(-45,60)
   \tkzDrawLine(I,J)          \tkzDrawSegment(A,B)
  \end{scope}
  \tkzDrawPoints(A,B,I,J)     \tkzLabelPoints(A,B)
   \tkzLabelPoints[right](I,J)
\end{tikzpicture}
```

### 19.4.3. Another use of \tkzFindSlopeAngle




```
\begin{tikzpicture}[scale=1.5]
  \tkzDefPoint(1,2){A}    \tkzDefPoint(3,4){B}
  \tkzDefPoint(3,2){C}    \tkzDefPoint(3,1){D}
  \tkzDrawSegments(A,B A,C A,D)
  \tkzDrawPoints[color=red](A,B,C,D)
  \tkzLabelPoints(A,B,C,D)
  \tkzFindSlopeAngle(A,B)\tkzGetAngle{SAB}
  \tkzFindSlopeAngle(A,C)\tkzGetAngle{SAC}
  \tkzFindSlopeAngle(A,D)\tkzGetAngle{SAD}
  \pgfkeys{/pgf/number format/.cd,fixed,precision=2}
  \tkzText(1,5){The slope of (AB) is :
     $\pgfmathprintnumber{\SAB}^\circ$}
  \tkzText(1,4.5){The slope of (AC) is :
     $\pgfmathprintnumber{\SAC}^\circ$}
  \tkzText(1,4){The slope of (AD) is :
     $\pgfmathprintnumber{\SAD}^\circ$}
\end{tikzpicture}
```

## 20. Random point definition

At the moment there are four possibilities:

1. point in a rectangle;
2. on a segment;
3. on a straight line;
4. on a circle.

### 20.1. Obtaining random points

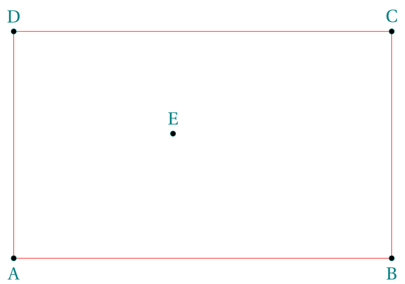
This is the new version that replaces `\tkzGetRandPointOn`.

`\tkzDefRandPointOn[⟨local options⟩]`

The result is a point with a random position that can be named with the macro `\tkzGetPoint`. It is possible to use `tkzPointResult` if it is not necessary to retain the results.

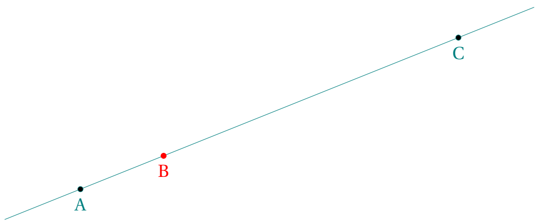
| options | default | definition |
|---|---|---|
| `rectangle=pt1 and pt2` | | `[rectangle=A and B]` |
| `segment= pt1--pt2` | | `[segment=A--B]` |
| `line=pt1--pt2` | | `[line=A--B]` |
| `circle =center pt1 radius dim` | | `[circle = center A radius 2]` |
| `circle through=center pt1 through pt2` | | `[circle through= center A through B]` |
| `disk through=center pt1 through pt2` | | `[disk through=center A through B]` |

### 20.1.1. Random point in a rectangle



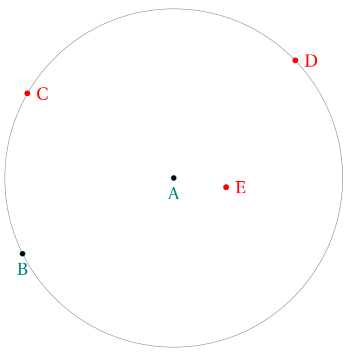

```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,5/3/C}
  \tkzDefRandPointOn[rectangle = A and C]
  \tkzGetPoint{E}
  \tkzDefRectangle(A,C)\tkzGetPoints{B}{D}
  \tkzDrawPolygon[red](A,...,D)
  \tkzDrawPoints(A,...,E)
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[above](C,D,E)
\end{tikzpicture}
```

### 20.1.2. Random point on a segment or a line




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,5/2/C}
  \tkzDefRandPointOn[segment = A--C]\tkzGetPoint{B}
  \tkzDrawLine(A,C)
  \tkzDrawPoints(A,C) \tkzDrawPoint[red](B)
  \tkzLabelPoints(A,C) \tkzLabelPoints[red](B)
\end{tikzpicture}
```

### 20.1.3. Random point on a circle or a disk




```
\begin{tikzpicture}
\tkzDefPoints{3/2/A,1/1/B}
\tkzCalcLength(A,B) \tkzGetLength{rAB}
\tkzDefRandPointOn[circle = center A radius \rAB]
\tkzGetPoint{C}
\tkzDefRandPointOn[circle through= center A through B]
\tkzGetPoint{D}
\tkzDefRandPointOn[disk through=center A through B]
\tkzGetPoint{E}
\tkzDrawCircle(A,B)
\tkzDrawPoints(A,B)
\tkzLabelPoints(A,B)
\tkzDrawPoints[red](C,D,E)
\tkzLabelPoints[red,right](C,D,E)
\end{tikzpicture}
```

# Part IV.

# Drawing and Filling

## 21. Drawing

**tkz-euclide** can draw 5 types of objects : point, line or line segment, circle, arc and sector.

### 21.1. Draw a point or some points

There are two possibilities : `\tkzDrawPoint` for a single point or `\tkzDrawPoints` for one or more points.

#### 21.1.1. Drawing points \tkzDrawPoint

`\tkzDrawPoint[⟨local options⟩](⟨name⟩)`

| arguments | default | definition |
|---|---|---|
| name of point | no default | Only one point name is accepted |

The argument is required. The disc takes the color of the circle, but lighter. It is possible to change everything. The point is a node and therefore it is invariant if the drawing is modified by scaling.

| options | default | definition |
|---|---|---|
| TikZ options | | all TikZ options are valid. |
| shape | circle | Possible **cross** or **cross out** |
| size | 6 | 6× **\pgflinewidth** |
| color | black | the default color can be changed |

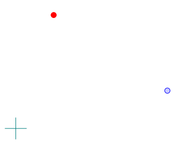
We can create other forms such as **cross**

By default, **point style** is defined like this :

```
\tikzset{point style/.style = {%
        draw         = black,
        inner sep    = 0pt,
        shape        = circle,
        minimum size = 3 pt,
        fill         = black
                          }
      }
```

#### 21.1.2. Example of point drawings

Note that **scale** does not affect the shape of the dots. Which is normal. Most of the time, we are satisfied with a single point shape that we can define from the beginning, either with a macro or by modifying a configuration file.



```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoint(1,3){A}
 \tkzDefPoint(4,1){B}
 \tkzDefPoint(0,0){O}
 \tkzDrawPoint[color=red](A)
 \tkzDrawPoint[fill=blue!20,draw=blue](B)
 \tkzDrawPoint[shape=cross,size=8pt,color=teal](O)
\end{tikzpicture}
```

It is possible to draw several points at once but this macro is a little slower than the previous one. Moreover, we have to make do with the same options for all the points.

`\tkzDrawPoints[⟨local options⟩](⟨liste⟩)`

| arguments | default | definition |
|---|---|---|
| points list | no default | example `\tkzDrawPoints(A,B,C)` |

| options | default | definition |
|---|---|---|
| shape | circle | Possible **cross** or **cross out** |
| size | 6 | 6× `\pgflinewidth` |
| color | black | the default color can be changed |

Beware of the final s, an oversight leads to cascading errors if you try to draw multiple points. The options are the same as for the previous macro.

### 21.1.3. Example

```
\begin{tikzpicture}
\tkzDefPoints{1/3/A,4/1/B,0/0/C}
\tkzDrawPoints[size=3,color=red,fill=red!50](A,B,C)
\end{tikzpicture}
```

## 22. Drawing the lines

The following macros are simply used to draw, name lines.

### 22.1. Draw a straight line

To draw a normal straight line, just give a couple of points. You can use the **add** option to extend the line (This option is due to `Mark Wibrow`, see the code below).
The style of a line is by default :

```
\tikzset{line style/.style = {%
  line width = 0.6pt,
  color      = black,
  style      = solid,
  add        = {.2} and  {.2}%
 }}
```

with

```
\tikzset{%
  add/.style args={#1 and #2}{
      to path={%
($(\tikztostart)!-#1!(\tikztotarget)$)--($(\tikztotarget)!-#2!(\tikztostart)$)%
\tikztonodes}}}
```

You can modify this style with `\tkzSetUpLine` see 40.1

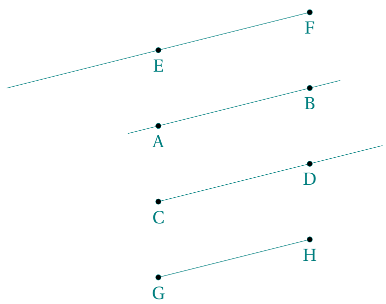
`\tkzDrawLine[⟨local options⟩](⟨pt1,pt2⟩)`

The arguments are a list of two points or three points. It would be possible, as for a half line, to create a style with `\add`.

| options | default | definition |
|---|---|---|
| TikZ options | | all TikZ options are valid. |
| add | 0.2 and 0.2 | add = kl and kr, … |
| … | … | allows the segment to be extended to the left and right. |

`add` defines the length of the line passing through the points pt1 and pt2. Both numbers are percentages. The styles of TikZ are accessible for plots.

### 22.1.1. Examples with add



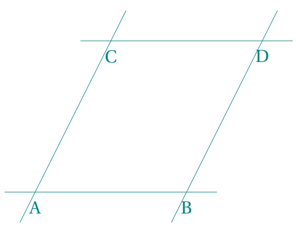

```
\begin{tikzpicture}
 \tkzInit[xmin=-2,xmax=3,ymin=-2.25,ymax=2.25]
 \tkzClip[space=.25]
 \tkzDefPoint(0,0){A} \tkzDefPoint(2,0.5){B}
 \tkzDefPoint(0,-1){C}\tkzDefPoint(2,-0.5){D}
 \tkzDefPoint(0,1){E} \tkzDefPoint(2,1.5){F}
 \tkzDefPoint(0,-2){G} \tkzDefPoint(2,-1.5){H}
 \tkzDrawLine(A,B)    \tkzDrawLine[add = 0 and .5](C,D)
 \tkzDrawLine[add = 1 and 0](E,F)
 \tkzDrawLine[add = 0 and 0](G,H)
 \tkzDrawPoints(A,B,C,D,E,F,G,H)
 \tkzLabelPoints(A,B,C,D,E,F,G,H)
\end{tikzpicture}
```

It is possible to draw several lines, but with the same options.

`\tkzDrawLines[⟨local options⟩](⟨pt1,pt2 pt3,pt4 ...⟩)`

Arguments are a list of pairs of points separated by spaces. The styles of TikZ are available for the draws.

### 22.1.2. Example with \tkzDrawLines




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(2,0){B}
  \tkzDefPoint(1,2){C}
  \tkzDefPoint(3,2){D}
  \tkzDrawLines(A,B C,D A,C B,D)
  \tkzLabelPoints(A,B,C,D)
\end{tikzpicture}
```

## 23. Drawing a segment

There is, of course, a macro to simply draw a segment.

### 23.1. Draw a segment \tkzDrawSegment

`\tkzDrawSegment[⟨local options⟩](⟨pt1,pt2⟩)`

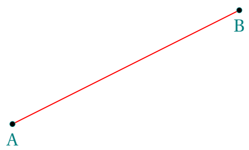
The arguments are a list of two points. The styles of TikZ are available for the drawings.

| argument | example | definition |
|---|---|---|
| (pt1,pt2) | (A,B) | draw the segment [A,B] |

| options | example | definition |
|---|---|---|
| TikZ options | | all TikZ options are valid. |
| dim | no default | dim = {label,dim,option}, … |
| … | … | allows you to add dimensions to a figure. |

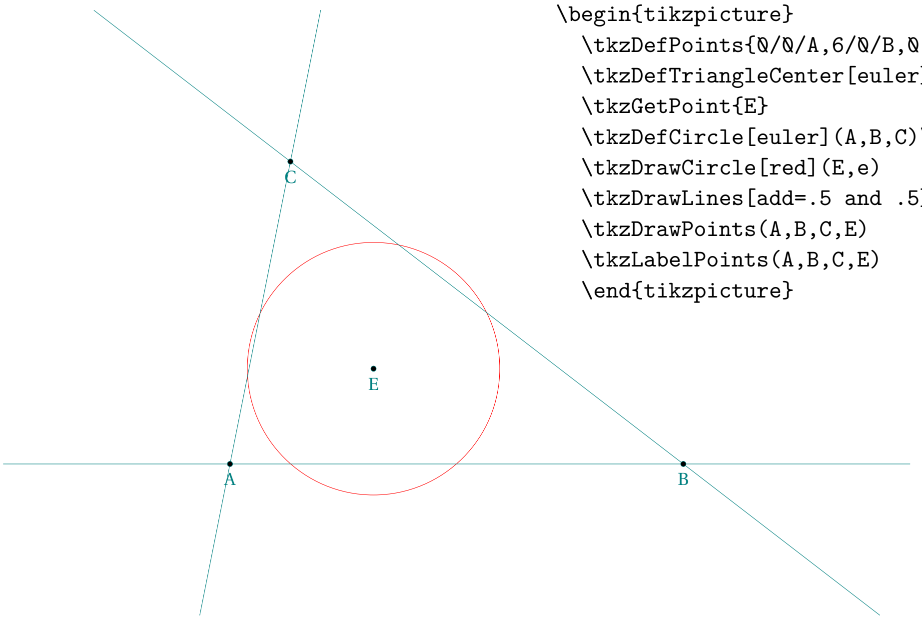
This is of course equivalent to `\draw (A)--(B);`. You can also use the option **add**.

### 23.1.1. Example with point references




```
\begin{tikzpicture}[scale=1.5]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(2,1){B}
  \tkzDrawSegment[color=red,thin](A,B)
  \tkzDrawPoints(A,B)
  \tkzLabelPoints(A,B)
\end{tikzpicture}
```

### 23.1.2. Example of extending an segment with option add

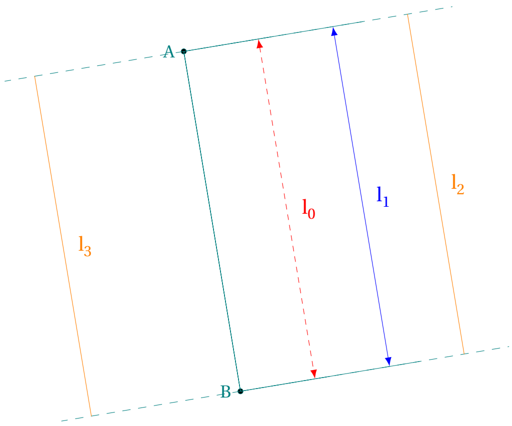



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
  \tkzDefTriangleCenter[euler](A,B,C)
  \tkzGetPoint{E}
  \tkzDefCircle[euler](A,B,C)\tkzGetPoints{E}{e}
  \tkzDrawCircle[red](E,e)
  \tkzDrawLines[add=.5 and .5](A,B A,C B,C)
  \tkzDrawPoints(A,B,C,E)
  \tkzLabelPoints(A,B,C,E)
  \end{tikzpicture}
```

### 23.1.3. Adding dimensions with option dim new code from Muzimuzhi Z

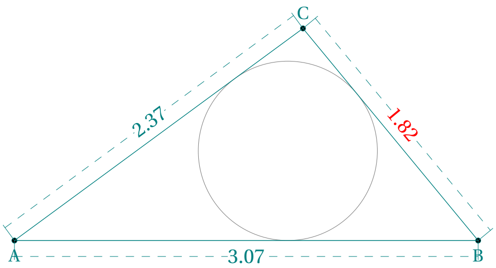
This code comes from an answer to this question on tex.stackexchange.com (change-color-and-style-of-dimension-lines-in-tkz-euclide ). The code of `dim` is based on options of TikZ, you must add the units. You can use now two styles : `dim style` and `dim fence style`. You have several ways to use them. I'll let you look at the examples to see what you can do with these styles.

```
\tikzset{dim style/.append style={dashed}} % append if you want to keep precedent style.
or
\begin{scope}[ dim style/.append style={orange},
    dim fence style/.style={dashed}]
```



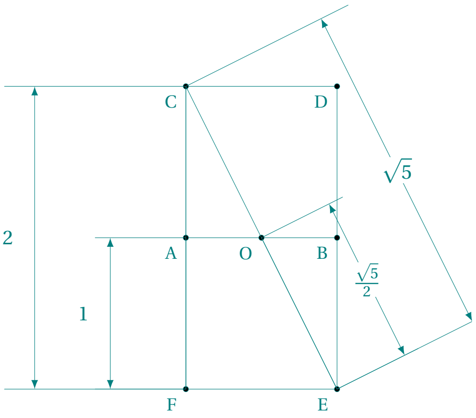

```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/3/A, 1/-3/B}
  \tkzDrawPoints(A,B)
  \tkzDrawSegment[dim={\(l_0\),1cm,right=2mm},
    dim style/.append style={red,
    dash pattern={on 2pt off 2pt}}](A,B)
  \tkzDrawSegment[dim={\(l_1\),2cm,right=2mm},
    dim style/.append style={blue}](A,B)
  \begin{scope}[ dim style/.style={orange},
      dim fence style/.style={dashed}]
    \tkzDrawSegment[dim={\(l_2\),3cm,right=2mm}](A,B)
    \tkzDrawSegment[dim={\(l_3\),-2cm,right=2mm}](A,B)
  \end{scope}
  \tkzLabelPoints[left](A,B)
\end{tikzpicture}
```

### 23.1.4. Adding dimensions with option dim partI




```
\begin{tikzpicture}[scale=2]
\pgfkeys{/pgf/number format/.cd,fixed,precision=2}
\tkzDefPoint(0,0){A}
\tkzDefPoint(3.07,0){B}
\tkzInterCC[R](A,2.37)(B,1.82)
\tkzGetPoints{C}{C'}
\tkzDefCircle[in](A,B,C) \tkzGetPoints{G}{g}
\tkzDrawCircle(G,g)
\tkzDrawPolygon(A,B,C)
\tkzDrawPoints(A,B,C)
\tkzCalcLength(A,B)\tkzGetLength{ABl}
\tkzCalcLength(B,C)\tkzGetLength{BCl}
\tkzCalcLength(A,C)\tkzGetLength{ACl}
\begin{scope}[dim style/.style={dashed,sloped,teal}]
  \tkzDrawSegment[dim={\pgfmathprintnumber\BCl,6pt,%
                                    text=red}](C,B)
  \tkzDrawSegment[dim={\pgfmathprintnumber\ACl,%
                                      6pt,}](A,C)
  \tkzDrawSegment[dim={\pgfmathprintnumber\ABl,%
                                    -6pt,}](A,B)
\end{scope}
\tkzLabelPoints(A,B) \tkzLabelPoints[above](C)
\end{tikzpicture}
```

#### 23.1.5. Adding dimensions with option dim part II



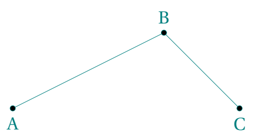

```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{0/0/O,-2/0/A,2/0/B,
                -2/4/C,2/4/D,2/-4/E,-2/-4/F}
  \tkzDrawPolygon(C,...,F)
  \tkzDrawSegments(A,B)
  \tkzDrawPoints(A,...,F,O)
  \tkzLabelPoints[below left](A,...,F,O)
  \tkzDrawSegment[dim={ $\sqrt{5}$,2cm,}](C,E)
  \tkzDrawSegment[dim={ $\frac{\sqrt{5}}{2}$,1cm,}](O,E)
  \tkzDrawSegment[dim={ $2$,2cm,left=8pt}](F,C)
  \tkzDrawSegment[dim={ $1$,1cm,left=8pt}](F,A)
\end{tikzpicture}
```

### 23.2. Drawing segments \tkzDrawSegments

If the options are the same we can plot several segments with the same macro.

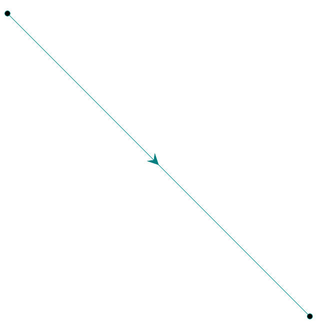
\tkzDrawSegments[⟨local options⟩](⟨pt1,pt2 pt3,pt4 ...⟩)

The arguments are a two-point couple list. The styles of TikZ are available for the plots.




```
\begin{tikzpicture}
  \tkzInit[xmin=-1,xmax=3,ymin=-1,ymax=2]
  \tkzClip[space=1]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(2,1){B}
  \tkzDefPoint(3,0){C}
  \tkzDrawSegments(A,B B,C)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,C)
  \tkzLabelPoints[above](B)
\end{tikzpicture}
```

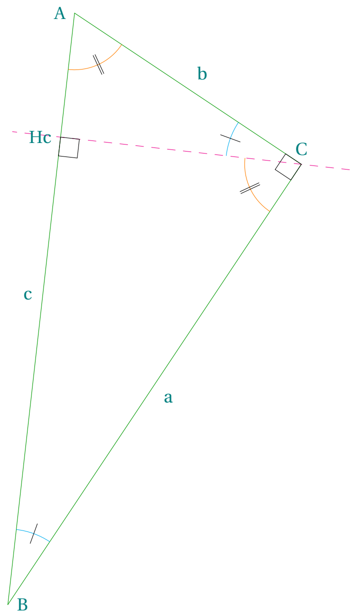
#### 23.2.1. Place an arrow on segment



```
\begin{tikzpicture}
\tkzSetUpStyle[postaction=decorate,
    decoration={markings,
    mark=at position .5 with {\arrow[thick]{#1}}
      }]{myarrow}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(4,-4){B}
  \tkzDrawSegments[myarrow=stealth](A,B)
  \tkzDrawPoints(A,B)
\end{tikzpicture}
```

## 23.3. Drawing line segment of a triangle

### 23.3.1. How to draw Altitude




```
\begin{tikzpicture}[rotate=-90]
\tkzDefPoint(0,1){A}
\tkzDefPoint(2,4){C}
\tkzDefPointWith[orthogonal normed,K=7](C,A)
\tkzGetPoint{B}
\tkzDefSpcTriangle[orthic,name=H](A,B,C){a,b,c}
\tkzDrawLine[dashed,color=magenta](C,Hc)
\tkzDrawSegment[green!60!black](A,C)
\tkzDrawSegment[green!60!black](C,B)
\tkzDrawSegment[green!60!black](B,A)
\tkzLabelPoint[left](A){$A$}
\tkzLabelPoint[right](B){$B$}
\tkzLabelPoint[above](C){$C$}
\tkzLabelPoint[left](Hc){$Hc$}
\tkzLabelSegment[auto](B,A){$c$}
\tkzLabelSegment[auto,swap](B,C){$a$}
\tkzLabelSegment[auto,swap](C,A){$b$}
\tkzMarkAngle[size=1,color=cyan,mark=|](C,B,A)
\tkzMarkAngle[size=1,color=cyan,mark=|](A,C,Hc)
\tkzMarkAngle[size=0.75,
              color=orange,mark=||](Hc,C,B)
\tkzMarkAngle[size=0.75,
              color=orange,mark=||](B,A,C)
\tkzMarkRightAngle(A,C,B)
\tkzMarkRightAngle(B,Hc,C)
\end{tikzpicture}
```

## 23.4. Drawing a polygon

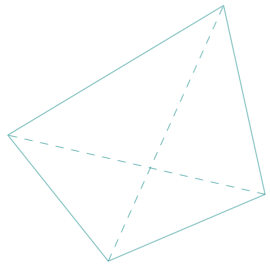
**\tkzDrawPolygon[⟨local options⟩](⟨points list⟩)**

Just give a list of points and the macro plots the polygon using the Ti*k*Z options present. You can replace (A, B, C, D, E) by (A, ..., E) and ($P_1, P_2, P_3, P_4, P_5$) by ($P_1$, P..., $P_5$)

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2,pt3,...⟩) | `\tkzDrawPolygon[gray,dashed](A,B,C)` | Drawing a triangle |

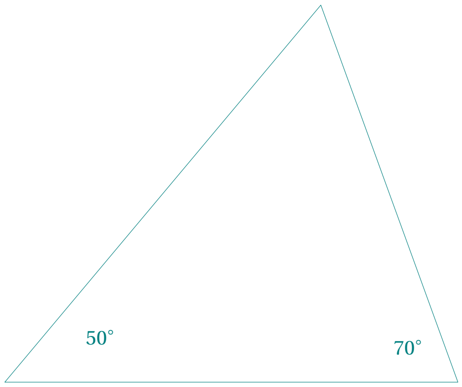
| options | default | example |
|---|---|---|
| Options TikZ | ... | `\tkzDrawPolygon[red,line width=2pt](A,B,C)` |

### 23.4.1. \tkzDrawPolygon



```
\begin{tikzpicture} [rotate=18,scale=1]
 \tkzDefPoints{0/0/A,2.25/0.2/B,2.5/2.75/C,-0.75/2/D}
 \tkzDrawPolygon(A,B,C,D)
 \tkzDrawSegments[style=dashed](A,C B,D)
\end{tikzpicture}
```

#### 23.4.2. Option two angles




```
\begin{tikzpicture}
\tkzDefPoint(0,0){A}
\tkzDefPoint(6,0){B}
\tkzDefTriangle[two angles = 50 and 70](A,B) \tkzGetPoint{C}
\tkzDrawPolygon(A,B,C)
\tkzLabelAngle[pos=1.4](B,A,C){$50^\circ$}
\tkzLabelAngle[pos=0.8](C,B,A){$70^\circ$}
\end{tikzpicture}
```

#### 23.4.3. Style of line

```
\begin{tikzpicture}[scale=.6]
\tkzSetUpLine[line width=5mm,color=teal]
\tkzDefPoint(0,0){O}
\foreach \i in {0,...,5}{%
 \tkzDefPoint({30+60*\i}:4){p\i}}
\tkzDefMidPoint(p1,p3) \tkzGetPoint{m1}
\tkzDefMidPoint(p3,p5) \tkzGetPoint{m3}
\tkzDefMidPoint(p5,p1) \tkzGetPoint{m5}
\tkzDrawPolygon[line join=round](p1,p3,p5)
\tkzDrawPolygon[teal!80,
line join=round](p0,p2,p4)
\tkzDrawSegments(m1,p3 m3,p5 m5,p1)
\tkzDefCircle[R](O,4.8)\tkzGetPoint{o}
\tkzDrawCircle[teal](O,o)
\end{tikzpicture}
```

### 23.5. Drawing a polygonal chain

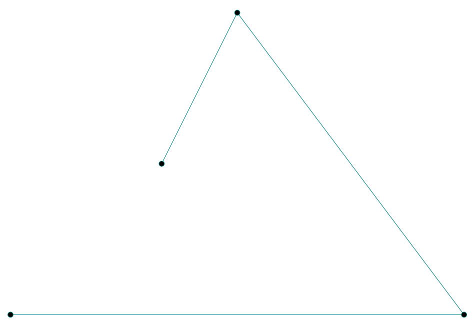
`\tkzDrawPolySeg[⟨local options⟩](⟨points list⟩)`

Just give a list of points and the macro plots the polygonal chain using the Ti*k*Z options present.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2,pt3,...⟩) | `\tkzDrawPolySeg[gray,dashed](A,B,C)` | Drawing a triangle |

| options | default | example |
|---|---|---|
| Options TikZ | ... | `\tkzDrawPolySeg[red,line width=2pt](A,B,C)` |

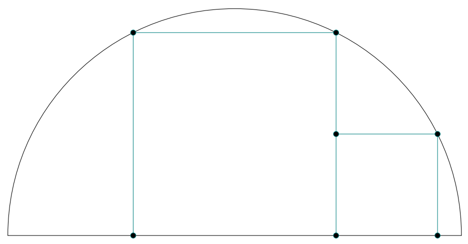
### 23.5.1. Polygonal chain



```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,6/0/B,3/4/C,2/2/D}
 \tkzDrawPolySeg(A,...,D)
 \tkzDrawPoints(A,...,D)
\end{tikzpicture}
```

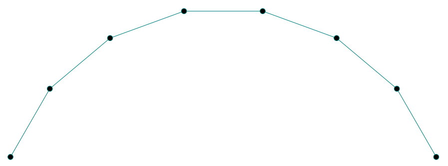
### 23.5.2. The idea is to inscribe two squares in a semi-circle.

A Sangaku look! It is a question of proving that one can inscribe in a half-disc, two squares, and to determine the length of their respective sides according to the radius.



```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/A,8/0/B,4/0/I}
  \tkzDefSquare(A,B)    \tkzGetPoints{C}{D}
  \tkzInterLC(I,C)(I,B) \tkzGetPoints{E'}{E}
  \tkzInterLC(I,D)(I,B) \tkzGetPoints{F'}{F}
  \tkzDefPointsBy[projection=onto A--B](E,F){H,G}
  \tkzDefPointsBy[symmetry = center H](I){J}
  \tkzDefSquare(H,J)     \tkzGetPoints{K}{L}
  \tkzDrawSector(I,B)(A)
  \tkzDrawPolySeg(H,E,F,G)
  \tkzDrawPolySeg(J,K,L)
  \tkzDrawPoints(E,G,H,F,J,K,L)
\end{tikzpicture}
```

### 23.5.3. Polygonal chain: index notation



```
\begin{tikzpicture}
\foreach \pt in {1,2,...,8} {%
\tkzDefPoint(\pt*20:3){P_\pt}}
\tkzDrawPolySeg(P_1,P_...,P_8)
\tkzDrawPoints(P_1,P_...,P_8)
\end{tikzpicture}
```

## 24. Draw a circle with \tkzDrawCircle

### 24.1. Draw one circle

`\tkzDrawCircle[⟨local options⟩](⟨A,B⟩)`

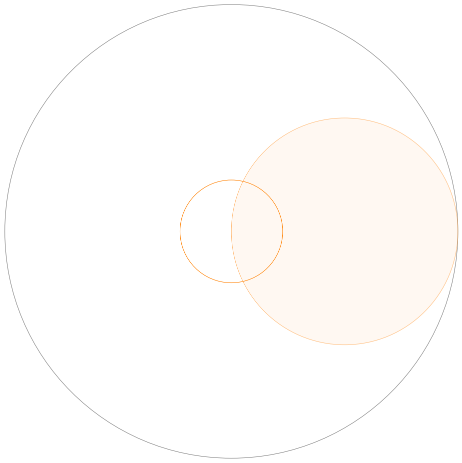
Attention you need only two points to define a radius. An additional option `R` is available to give a measure directly.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | (⟨A,B⟩) | `A center through B` |

Of course, you have to add all the styles of Ti*k*Z for the tracings...

#### 24.1.1. Circles and styles, draw a circle and color the disc

We'll see that it's possible to colour in a disc while tracing the circle.



```
\begin{tikzpicture}
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(3,0){A}
 % circle with center O and passing through A
  \tkzDrawCircle(O,A)
 % diameter circle $[OA]$
 \tkzDefCircle[diameter](O,A) \tkzGetPoint{I}
 \tkzDrawCircle[new,fill=orange!10,opacity=.5](I,A)
 % circle with center O and radius = exp(1) cm
  \edef\rayon{\fpeval{0.25*exp(1)}}
  \tkzDefCircle[R](O,\rayon) \tkzGetPoint{o}
   \tkzDrawCircle[color=orange](O,o)
\end{tikzpicture}
```

### 24.2. Drawing circles

`\tkzDrawCircles[⟨local options⟩](⟨A,B C,D …⟩)`

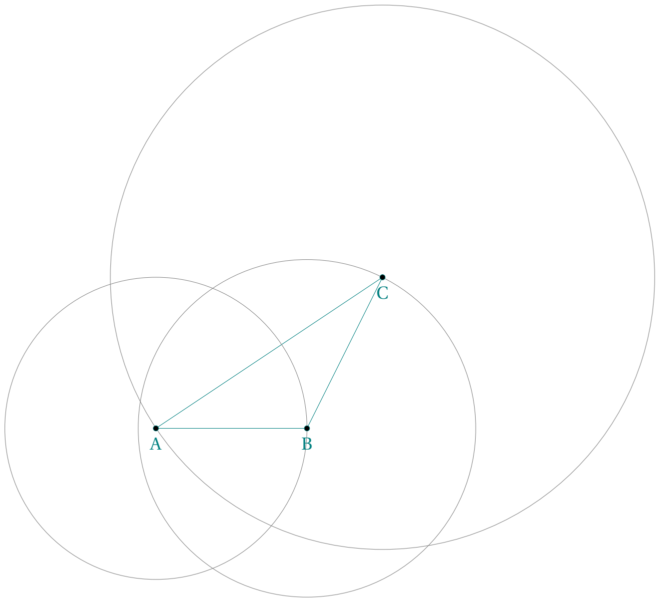
Attention, the arguments are lists of two points. The circles that can be drawn are the same as in the previous macro. An additional option **R** is available to give a measure directly.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2 pt3,pt4 ...⟩) | (⟨A,B C,D⟩) | List of two points |

| options | default | definition |
|---|---|---|
| through | through | circle with two points defining a radius |

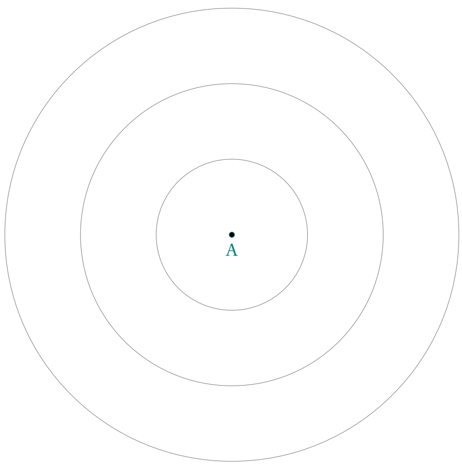
You do not need to use the default option **through**. Of course, you have to add all the styles of TikZ for the tracings...

### 24.2.1. Circles defined by a triangle.



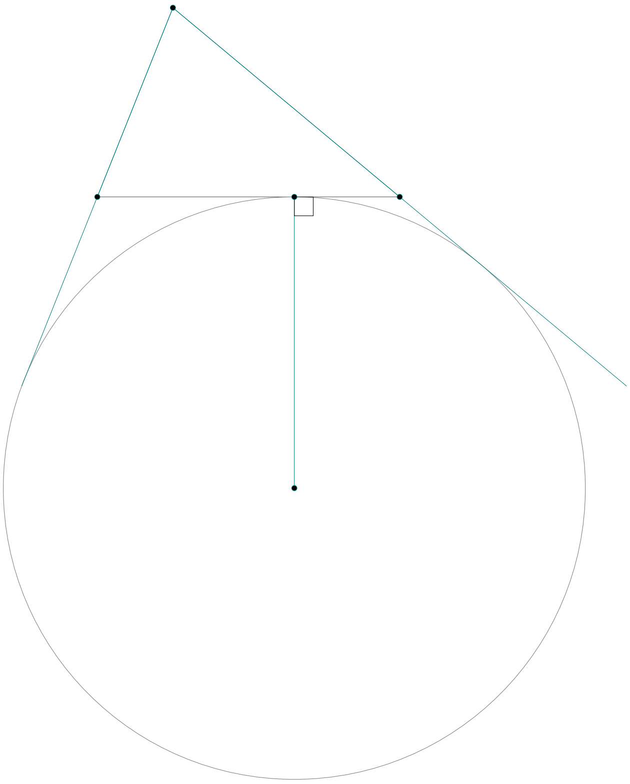

```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,2/0/B,3/2/C}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawCircles(A,B B,C C,A)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,B,C)
\end{tikzpicture}
```

### 24.2.2. Concentric circles.




```
\begin{tikzpicture}
   \tkzDefPoints{0/0/A,1/0/a,2/0/b,3/0/c}
   \tkzDrawCircles(A,a A,b A,c)
   \tkzDrawPoint(A)
   \tkzLabelPoints(A)
\end{tikzpicture}
```

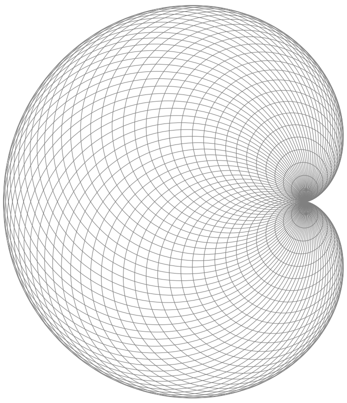
### 24.2.3. Exinscribed circles.



```
\begin{tikzpicture}[scale=1]
\tkzDefPoints{0/0/A,4/0/B,1/2.5/C}
\tkzDrawPolygon(A,B,C)
\tkzDefCircle[ex](B,C,A)
\tkzGetPoint{J_c} \tkzGetSecondPoint{T_c}
\tkzDrawCircle(J_c,T_c)
\tkzDrawLines[add=0 and 1](C,A C,B)
\tkzDrawSegment(J_c,T_c)
\tkzMarkRightAngle(J_c,T_c,B)
\tkzDrawPoints(A,B,C,J_c,T_c)
\end{tikzpicture}
```

### 24.2.4. Cardioid

Based on an idea by O. Reboux made with pst-eucl (Pstricks module) by D. Rodriguez.
Its name comes from the Greek *kardia (heart)*, in reference to its shape, and was given to it by Johan Castillon (Wikipedia).



```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,0){A}
  \foreach \ang in {5,10,...,360}{%
     \tkzDefPoint(\ang:2){M}
     \tkzDrawCircle(M,A)
   }
\end{tikzpicture}
```

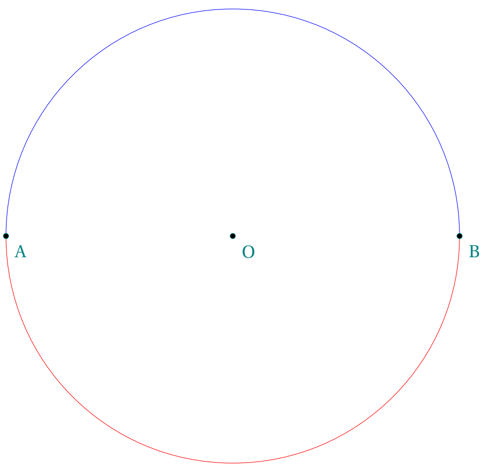
### 24.3. Drawing semicircle

`\tkzDrawSemiCircle[⟨local options⟩](⟨O,A⟩)`

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2⟩) | (⟨O,A⟩) | OA= radius |

O center A extremity of the semicircle

#### 24.3.1. Use of \tkzDrawSemiCircle



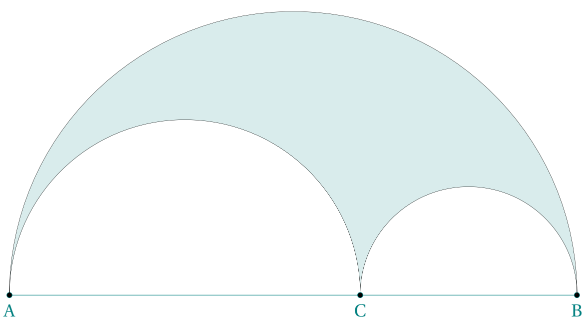

```
\begin{tikzpicture}
   \tkzDefPoint(0,0){A} \tkzDefPoint(6,0){B}
   \tkzDefMidPoint(A,B)  \tkzGetPoint{O}
   \tkzDrawSemiCircle[blue](O,B)
   \tkzDrawSemiCircle[red](O,A)
   \tkzDrawPoints(O,A,B)
   \tkzLabelPoints[below right](O,A,B)
 \end{tikzpicture}
```

### 24.4. Drawing semicircles

`\tkzDrawSemiCircles[⟨local options⟩](⟨A,B C,D …⟩)`

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2 pt3,pt4 ...⟩) | (⟨A,B C,D⟩) | List of two points |

#### 24.4.1. Use of \tkzDrawSemiCircles : Golden arbelos



```
\begin{tikzpicture}[scale=.75]
\tkzDefPoints{0/0/A,10/0/B}
\tkzDefGoldenRatio(A,B) \tkzGetPoint{C}
\tkzDefMidPoint(A,B)                    \tkzGetPoint{O_0}
\tkzDefMidPoint(A,C)                    \tkzGetPoint{O_1}
\tkzDefMidPoint(C,B)                    \tkzGetPoint{O_2}
\tkzLabelPoints(A,B,C)
\tkzDrawSegment(A,B)
\tkzDrawPoints(A,B,C)
\begin{scope}[local bounding box = graph]
  \tkzDrawSemiCircles[color=black](O_0,B)
\end{scope}
\useasboundingbox (graph.south west) rectangle (graph.north east);
\tkzClipCircle[out](O_1,C)\tkzClipCircle[out](O_2,B)
\tkzDrawSemiCircles[draw=none,fill=teal!15](O_0,B)
\tkzDrawSemiCircles[color=black](O_1,C O_2,B)
\end{tikzpicture}
```

# 25. Draw an ellipse with \tkzDrawEllipse

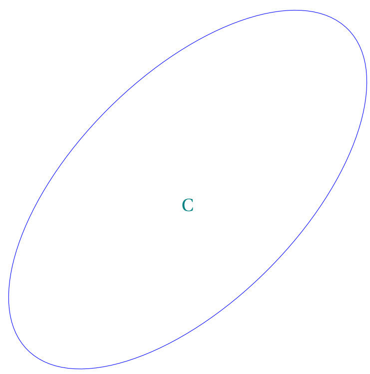
## 25.1. Draw an ellipse

**\tkzDrawEllipse[⟨local options⟩](⟨C,a,b,An⟩)**

| arguments | example | explanation |
|---|---|---|
| (⟨C,a,b,An⟩) | (⟨C,4,2,45⟩) | C center; 4 and 2 lengths of half-axis<br>45 slope of main axis |

Of course, you have to add all the styles of TikZ for the tracings...

### 25.1.1. Example of drawing an ellipse




```
\begin{tikzpicture}[scale=.75]
   \tkzDefPoint(0,4){C}
   \tkzDrawEllipse[blue](C,4,2,45)
   \tkzLabelPoints(C)
\end{tikzpicture}
```

# 26. Drawing arcs

## 26.1. Macro: \tkzDrawArc

`\tkzDrawArc[⟨local options⟩](⟨O,...⟩)(⟨...⟩)`

This macro traces the arc of center O. Depending on the options, the arguments differ. It is a question of determining a starting point and an end point. Either the starting point is given, which is the simplest, or the radius of the arc is given. In the latter case, it is necessary to have two angles. Either the angles can be given directly, or nodes associated with the center can be given to determine them. The angles are in degrees.

| options | default | definition |
|---|---|---|
| towards | towards | O is the center and the arc from A to (OB) |
| rotate | towards | the arc starts from A and the angle determines its length |
| R | towards | We give the radius and two angles |
| R with nodes | towards | We give the radius and two points |
| angles | towards | We give the radius and two points |
| delta | 0 | angle added on each side |
| reverse | false | inversion of the arc's path, interesting to inverse arrow |

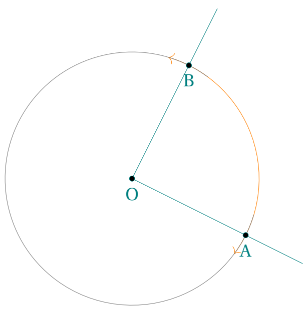
Of course, you have to add all the styles of Ti*k*Z for the tracings...

| options | arguments | example |
|---|---|---|
| towards | (⟨pt,pt⟩)(⟨pt⟩) | `\tkzDrawArc[delta=10](O,A)(B)` |
| rotate | (⟨pt,pt⟩)(⟨an⟩) | `\tkzDrawArc[rotate,color=red](O,A)(90)` |
| R | (⟨pt,r⟩)(⟨an,an⟩) | `\tkzDrawArc[R](O,2)(30,90)` |
| R with nodes | (⟨pt,r⟩)(⟨pt,pt⟩) | `\tkzDrawArc[R with nodes](O,2)(A,B)` |
| angles | (⟨pt,pt⟩)(⟨an,an⟩) | `\tkzDrawArc[angles](O,A)(0,90)` |

Here are a few examples:

#### 26.1.1. Option towards

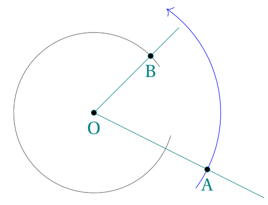
It's useless to put **towards**. In this first example the arc starts from A and goes to B. The arc going from B to A is different. The salient is obtained by going in the direct direction of the trigonometric circle.




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,-1){A}
  \tkzDefPointBy[rotation= center O angle 90](A)
  \tkzGetPoint{B}
  \tkzDrawArc[color=orange,<->](O,A)(B)
  \tkzDrawArc(O,B)(A)
  \tkzDrawLines[add = 0 and .5](O,A O,B)
  \tkzDrawPoints(O,A,B)
  \tkzLabelPoints[below](O,A,B)
\end{tikzpicture}
```

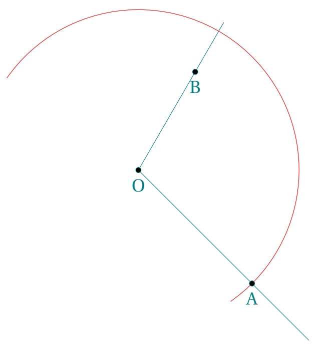
#### 26.1.2. Option towards

In this one, the arc starts from A but stops on the right (OB).



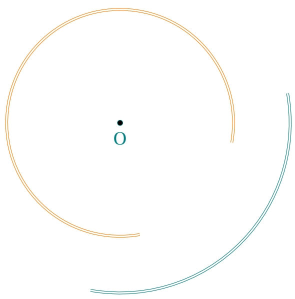

```
\begin{tikzpicture}[scale=0.75]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,-1){A}
  \tkzDefPoint(1,1){B}
  \tkzDrawArc[color=blue,->](O,A)(B)
  \tkzDrawArc[color=gray](O,B)(A)
  \tkzDrawArc(O,B)(A)
  \tkzDrawLines[add = 0 and .5](O,A O,B)
  \tkzDrawPoints(O,A,B)
  \tkzLabelPoints[below](O,A,B)
\end{tikzpicture}
```

### 26.1.3. Option rotate



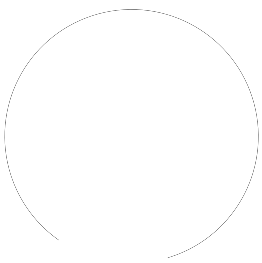

```
\begin{tikzpicture}[scale=0.75]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,-2){A}
  \tkzDefPoint(60:2){B}
  \tkzDrawLines[add = 0 and .5](O,A O,B)
  \tkzDrawArc[rotate,color=red](O,A)(180)
  \tkzDrawPoints(O,A,B)
  \tkzLabelPoints[below](O,A,B)
\end{tikzpicture}
```

### 26.1.4. Option R




```
\begin{tikzpicture}[scale=0.75]
  \tkzDefPoints{0/0/O}
  \tkzSetUpCompass[<->]
  \tkzDrawArc[R,color=teal,double](O,3)(270,360)
  \tkzDrawArc[R,color=orange,double](O,2)(0,270)
  \tkzDrawPoint(O)
  \tkzLabelPoint[below](O){$O$}
\end{tikzpicture}
```

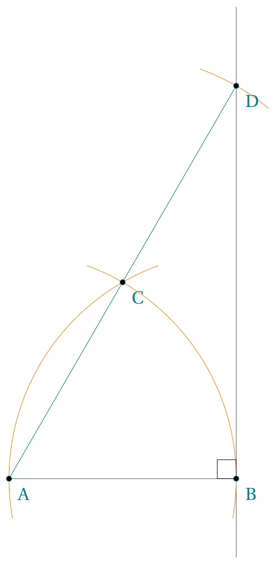
### 26.1.5. Option R with nodes



```
\begin{tikzpicture}[scale=0.75]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,-1){A}
  \tkzDefPoint(1,1){B}
  \tkzCalcLength(B,A)\tkzGetLength{radius}
  \tkzDrawArc[R with nodes](B,\radius)(A,O)
\end{tikzpicture}
```

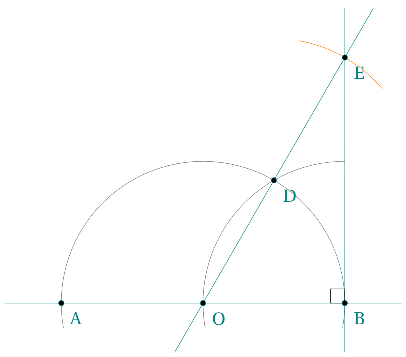
### 26.1.6. Option delta

This option allows a bit like `\tkzCompass` to place an arc and overflow on either side. delta is a measure in degrees.



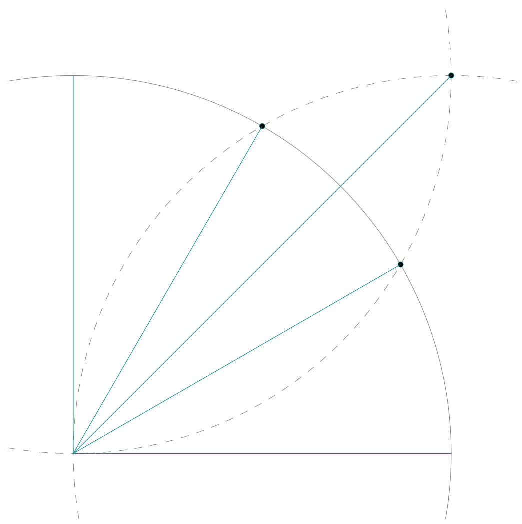

```
\begin{tikzpicture}
 \tkzDefPoint(0,0){A}
 \tkzDefPoint(3,0){B}
 \tkzDefPointBy[rotation= center A angle 60](B)
 \tkzGetPoint{C}
 \begin{scope}% style only local
   \tkzDefPointBy[symmetry= center C](A)
   \tkzGetPoint{D}
   \tkzDrawSegments(A,B A,D)
   \tkzDrawLine(B,D)
   \tkzSetUpCompass[color=orange]
   \tkzDrawArc[orange,delta=10](A,B)(C)
   \tkzDrawArc[orange,delta=10](B,C)(A)
   \tkzDrawArc[orange,delta=10](C,D)(D)
 \end{scope}

 \tkzDrawPoints(A,B,C,D)
 \tkzLabelPoints[below right](A,B,C,D)
 \tkzMarkRightAngle(D,B,A)
\end{tikzpicture}
```

### 26.1.7. Option angles: example 1



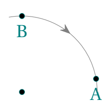

```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(5,0){B}
  \tkzDefPoint(2.5,0){O}
  \tkzDefPointBy[rotation=center O angle 60](B)
  \tkzGetPoint{D}
  \tkzDefPointBy[symmetry=center D](O)
  \tkzGetPoint{E}
  \begin{scope}
    \tkzDrawArc[angles](O,B)(0,180)
    \tkzDrawArc[angles,](B,O)(100,180)
    \tkzCompass[delta=20](D,E)
    \tkzDrawLines(A,B O,E B,E)
    \tkzDrawPoints(A,B,O,D,E)
  \end{scope}
  \tkzLabelPoints[below right](A,B,O,D,E)
  \tkzMarkRightAngle(O,B,E)
\end{tikzpicture}
```

### 26.1.8. Option angles: example 2



```
\begin{tikzpicture}
 \tkzDefPoint(0,0){O}
 \tkzDefPoint(5,0){I}
 \tkzDefPoint(0,5){J}
 \tkzInterCC(O,I)(I,O)\tkzGetPoints{B}{C}
 \tkzInterCC(O,I)(J,O)\tkzGetPoints{D}{A}
 \tkzInterCC(I,O)(J,O)\tkzGetPoints{L}{K}
 \tkzDrawArc[angles](O,I)(0,90)
 \tkzDrawArc[angles,color=gray,
             style=dashed](I,O)(90,180)
 \tkzDrawArc[angles,color=gray,
             style=dashed](J,O)(-90,0)
 \tkzDrawPoints(A,B,K)
 \foreach \point in {I,A,B,J,K}{%
             \tkzDrawSegment(O,\point)}
\end{tikzpicture}
```

### 26.1.9. Option reverse: inversion of the arrow




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/O,3/0/U}
  \tkzDefPoint(10:1){A}
  \tkzDefPoint(90:1){B}
  \tkzLabelPoints(A,B)
  \tkzDrawArc[reverse,tkz arrow={Stealth}](O,A)(B)
  \tkzDrawPoints(A,B,O)
\end{tikzpicture}
```

## 27. Drawing a sector or sectors

### 27.1. \tkzDrawSector

Attention the arguments vary according to the options.

`\tkzDrawSector[⟨local options⟩](⟨O,...⟩)(⟨...⟩)`

| options | default | definition |
|---|---|---|
| towards | towards | O is the center and the arc from A to (OB) |
| rotate | towards | the arc starts from A and the angle determines its length |
| R | towards | We give the radius and two angles |
| R with nodes | towards | We give the radius and two points |

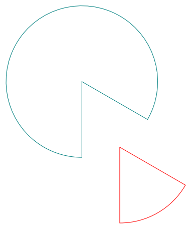
*You have to add, of course, all the styles of TikZ for tracings...*

| options | arguments | example |
|---|---|---|
| towards | (⟨pt,pt⟩)(⟨pt⟩) | \tkzDrawSector(O,A)(B) |
| rotate | (⟨pt,pt⟩)(⟨an⟩) | \tkzDrawSector[rotate,color=red](O,A)(90) |
| R | (⟨pt,r⟩)(⟨an,an⟩) | \tkzDrawSector[R,color=teal](O,2)(30,90) |
| R with nodes | (⟨pt,r⟩)(⟨pt,pt⟩) | \tkzDrawSector[R with nodes](O,2)(A,B) |

Here are a few examples:

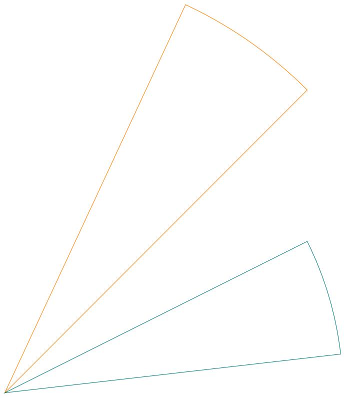
### 27.1.1. \tkzDrawSector and towards

There's no need to put **towards**. You can use **fill** as an option.



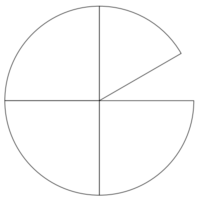
```
\begin{tikzpicture}
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(-30:1){A}
  \tkzDefPointBy[rotation = center O angle -60](A)
  \tkzDrawSector[teal](O,A)(tkzPointResult)
 \begin{scope}[shift={(-60:1)}]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(-30:1){A}
  \tkzDefPointBy[rotation = center O angle -60](A)
  \tkzDrawSector[red](O,tkzPointResult)(A)
  \end{scope}
\end{tikzpicture}
```

### 27.1.2. \tkzDrawSector and rotate



```
\begin{tikzpicture}[scale=2]
 \tkzDefPoints{0/0/O,2/2/A,2/1/B}
 \tkzDrawSector[rotate,orange](O,A)(20)
 \tkzDrawSector[rotate,teal](O,B)(-20)
\end{tikzpicture}
```

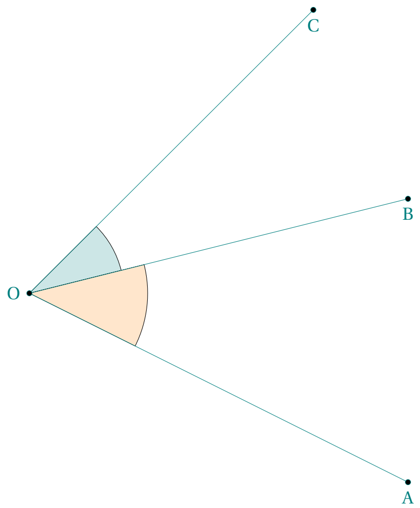
### 27.1.3. \tkzDrawSector and R



```
\begin{tikzpicture}[scale=1.25]
 \tkzDefPoint(0,0){O}
 \tkzDefPoint(2,-1){A}
 \tkzDrawSector[R](O,1)(30,90)
 \tkzDrawSector[R](O,1)(90,180)
 \tkzDrawSector[R](O,1)(180,270)
 \tkzDrawSector[R](O,1)(270,360)
\end{tikzpicture}
```

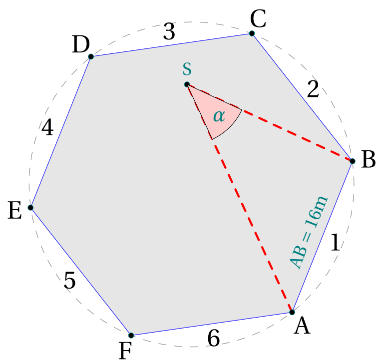
### 27.1.4. \tkzDrawSector and R with nodes

In this example I use the option **fill** but \tkzFillSector is possible.




```
\begin{tikzpicture}[scale=1.25]
 \tkzDefPoint(0,0){O}
 \tkzDefPoint(4,-2){A}
 \tkzDefPoint(4,1){B}
 \tkzDefPoint(3,3){C}
 \tkzDrawSector[R with nodes,%
               fill=teal!20](O,1)(B,C)
 \tkzDrawSector[R with nodes,%
               fill=orange!20](O,1.25)(A,B)
\tkzDrawSegments(O,A O,B O,C)
\tkzDrawPoints(O,A,B,C)
\tkzLabelPoints(A,B,C)
\tkzLabelPoints[left](O)
\end{tikzpicture}
```

### 27.1.5. \tkzDrawSector and R with nodes




```
\begin{tikzpicture} [scale=.4]
 \tkzDefPoints{-1/-2/A,1/3/B}
 \tkzDefRegPolygon[side,sides=6](A,B)
 \tkzGetPoint{O}
 \tkzDrawPolygon[fill=black!10, draw=blue](P1,P...,P6)
 \tkzLabelRegPolygon[sep=1.05](O){A,...,F}
 \tkzDrawCircle[dashed](O,A)
 \tkzLabelSegment[above,sloped,
                 midway](A,B){\(A B = 16m\)}
 \foreach \i  [count=\xi from 1]  in {2,...,6,1}
   {%
    \tkzDefMidPoint(P\xi,P\i)
    \path (O) to [pos=1.1] node {\xi} (tkzPointResult) ;
    }
  \tkzDefRandPointOn[segment = P3--P5]
  \tkzGetPoint{S}
  \tkzDrawSegments[thick,dashed,red](A,S S,B)
  \tkzDrawPoints(P1,P...,P6,S)
  \tkzLabelPoint[left,above](S){$S$}
  \tkzDrawSector[R with nodes,fill=red!20](S,2)(A,B)
  \tkzLabelAngle[pos=1.5](A,S,B){$\alpha$}
\end{tikzpicture}
```

## 27.2. Coloring a disc

This was possible with the macro `\tkzDrawCircle`, but disk tracing was mandatory, this is no longer the case.

`\tkzFillCircle[⟨local options⟩](⟨A,B⟩)`

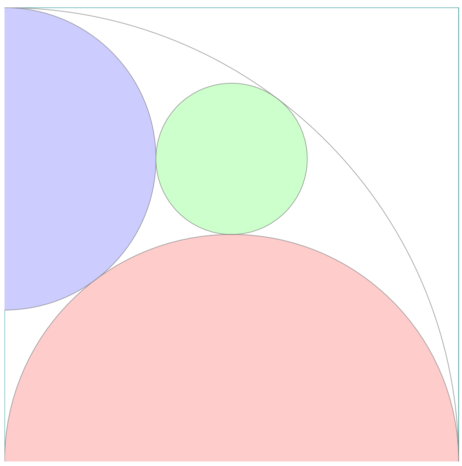
| options | default | definition |
|---|---|---|
| radius | radius | two points define a radius |
| R | radius | a point and the measurement of a radius |

You don't need to put **radius** because that's the default option. Of course, you have to add all the styles of Ti*kZ* for the plots.

### 27.2.1. Yin and Yang

```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(-4,0){A}
  \tkzDefPoint(4,0){B}
  \tkzDefPoint(-2,0){I}
  \tkzDefPoint(2,0){J}
  \tkzDrawSector[fill=teal](O,A)(B)
  \tkzFillCircle[fill=white](J,B)
  \tkzFillCircle[fill=teal](I,A)
  \tkzDrawCircle(O,A)
\end{tikzpicture}
```

### 27.2.2. From a sangaku



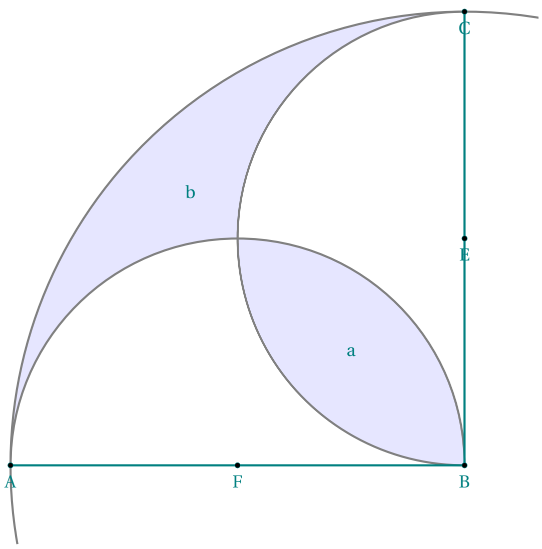
```
\begin{tikzpicture}
   \tkzDefPoint(0,0){B}  \tkzDefPoint(6,0){C}%
   \tkzDefSquare(B,C)    \tkzGetPoints{D}{A}
   \tkzClipPolygon(B,C,D,A)
   \tkzDefMidPoint(A,D)  \tkzGetPoint{F}
   \tkzDefMidPoint(B,C)  \tkzGetPoint{E}
   \tkzDefMidPoint(B,D)  \tkzGetPoint{Q}
   \tkzDefLine[tangent from = B](F,A)
   \tkzGetPoints{H}{G}
   \tkzInterLL(F,G)(C,D) \tkzGetPoint{J}
   \tkzInterLL(A,J)(F,E) \tkzGetPoint{K}
   \tkzDefPointBy[projection=onto B--A](K)
   \tkzGetPoint{M}
   \tkzDrawPolygon(A,B,C,D)
   \tkzFillCircle[red!20](E,B)
   \tkzFillCircle[blue!20](M,A)
   \tkzFillCircle[green!20](K,Q)
  \tkzDrawCircles(B,A M,A E,B K,Q)
\end{tikzpicture}
```

### 27.2.3. Clipping and filling part I



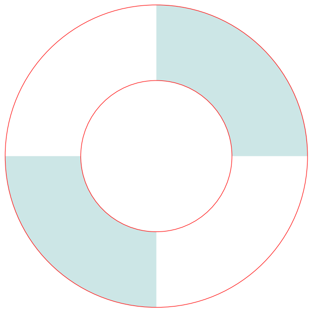
```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,4/0/B,2/2/O,3/4/X,4/1/Y,1/0/Z,
              0/3/W,3/0/R,4/3/S,1/4/T,0/1/U}
\tkzDefSquare(A,B)\tkzGetPoints{C}{D}
\tkzDefPointWith[colinear normed=at X,K=1](O,X)
 \tkzGetPoint{F}
\begin{scope}
  \tkzFillCircle[fill=teal!20](O,F)
  \tkzFillPolygon[white](A,...,D)
  \tkzClipPolygon(A,...,D)
  \foreach \c/\t in {S/C,R/B,U/A,T/D}
  {\tkzFillCircle[teal!20](\c,\t)}
\end{scope}
\foreach \c/\t in {X/C,Y/B,Z/A,W/D}
{\tkzFillCircle[white](\c,\t)}
  \foreach \c/\t in {S/C,R/B,U/A,T/D}
  {\tkzFillCircle[teal!20](\c,\t)}
\end{tikzpicture}
```

### 27.2.4. Clipping and filling part II




```
\begin{tikzpicture}[scale=.75]
\tkzDefPoints{0/0/A,8/0/B,8/8/C,0/8/D}
\tkzDefMidPoint(A,B) \tkzGetPoint{F}
\tkzDefMidPoint(B,C) \tkzGetPoint{E}
\tkzDefMidPoint(D,B) \tkzGetPoint{I}
\tkzDefMidPoint(I,B) \tkzGetPoint{a}
\tkzInterLC(B,I)(B,C) \tkzGetSecondPoint{K}
\tkzDefMidPoint(I,K) \tkzGetPoint{b}
\begin{scope}
  \tkzFillSector[fill=blue!10](B,C)(A)
  \tkzDefMidPoint(A,B) \tkzGetPoint{x}
  \tkzDrawSemiCircle[fill=white](x,B)
  \tkzDefMidPoint(B,C) \tkzGetPoint{y}
  \tkzDrawSemiCircle[fill=white](y,C)
  \tkzClipCircle(E,B)
  \tkzClipCircle(F,B)
  \tkzFillCircle[fill=blue!10](B,A)
\end{scope}
\tkzDrawSemiCircle[thick](F,B)
\tkzDrawSemiCircle[thick](E,C)
\tkzDrawArc[thick](B,C)(A)
\tkzDrawSegments[thick](A,B B,C)
\tkzDrawPoints(A,B,C,E,F)
\tkzLabelPoints[centered](a,b)
\tkzLabelPoints(A,B,C,E,F)
\end{tikzpicture}
```

### 27.2.5. Clipping and filling part III



```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A} \tkzDefPoint(1,0){B}
  \tkzDefPoint(2,0){C} \tkzDefPoint(-3,0){a}
  \tkzDefPoint(3,0){b}  \tkzDefPoint(0,3){c}
  \tkzDefPoint(0,-3){d}
\begin{scope}
 \tkzClipPolygon(a,b,c,d)
 \tkzFillCircle[teal!20](A,C)
\end{scope}
 \tkzFillCircle[white](A,B)
 \tkzDrawCircle[color=red](A,C)
 \tkzDrawCircle[color=red](A,B)
\end{tikzpicture}
```

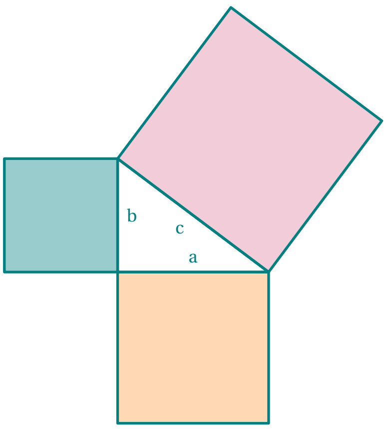
## 27.3. Coloring a polygon

**\tkzFillPolygon[⟨local options⟩](⟨points list⟩)**

You can color by drawing the polygon, but in this case you color the inside of the polygon without drawing it.

| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2,…⟩) | (⟨A,B,…⟩) | |

### 27.3.1. \tkzFillPolygon




```
\begin{tikzpicture}[scale=.5]
   \tkzDefPoint(0,0){C} \tkzDefPoint(4,0){A}
   \tkzDefPoint(0,3){B}
   \tkzDefSquare(B,A)      \tkzGetPoints{E}{F}
   \tkzDefSquare(A,C)      \tkzGetPoints{G}{H}
   \tkzDefSquare(C,B)       \tkzGetPoints{I}{J}
   \tkzFillPolygon[color  =  orange!30   ](A,C,G,H)
   \tkzFillPolygon[color  =  teal!40  ](C,B,I,J)
   \tkzFillPolygon[color  =  purple!20](B,A,E,F)
   \tkzDrawPolygon[line width  =  1pt](A,B,C)
   \tkzDrawPolygon[line width  =  1pt](A,C,G,H)
   \tkzDrawPolygon[line width  =  1pt](C,B,I,J)
   \tkzDrawPolygon[line width  =  1pt](B,A,E,F)
   \tkzLabelSegment[above](C,A){$a$}
   \tkzLabelSegment[right](B,C){$b$}
   \tkzLabelSegment[below left](B,A){$c$}
\end{tikzpicture}
```

## 27.4. \tkzFillSector

Attention the arguments vary according to the options.

`\tkzFillSector[⟨local options⟩](⟨O,...⟩)(⟨...⟩)`

| options | default | definition |
|---|---|---|
| towards | towards | O is the center and the arc from A to (OB) |
| rotate | towards | the arc starts from A and the angle determines its length |
| R | towards | We give the radius and two angles |
| R with nodes | towards | We give the radius and two points |

Of course, you have to add all the styles of Ti*k*Z for the tracings...

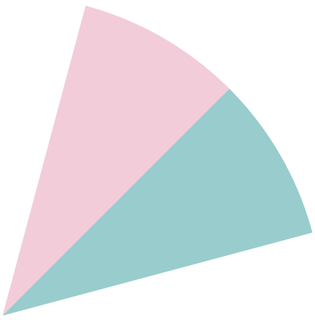
| options | arguments | example |
|---|---|---|
| towards | (⟨pt,pt⟩)(⟨pt⟩) | `\tkzFillSector(O,A)(B)` |
| rotate | (⟨pt,pt⟩)(⟨an⟩) | `\tkzFillSector[rotate,color=red](O,A)(90)` |
| R | (⟨pt,r⟩)(⟨an,an⟩) | `\tkzFillSector[R,color=blue](O,2)(30,90)` |
| R with nodes | (⟨pt,r⟩)(⟨pt,pt⟩) | `\tkzFillSector[R with nodes](O,2)(A,B)` |

#### 27.4.1. \tkzFillSector and towards

It is useless to put **towards** and you will notice that the contours are not drawn, only the surface is colored.

```
\begin{tikzpicture}[scale=.6]
\tkzDefPoint(0,0){O}
\tkzDefPoint(-30:3){A}
\tkzDefPointBy[rotation = center O angle -60](A)
\tkzFillSector[fill=purple!20](O,A)(tkzPointResult)
  \begin{scope}[shift={(-60:1)}]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(-30:3){A}
  \tkzDefPointBy[rotation = center O angle -60](A)
  \tkzGetPoint{A'}
  \tkzFillSector[color=teal!40](O,A')(A)
    \end{scope}
\end{tikzpicture}
```

#### 27.4.2. \tkzFillSector and rotate



```
\begin{tikzpicture}[scale=1.5]
 \tkzDefPoint(0,0){O} \tkzDefPoint(2,2){A}
 \tkzFillSector[rotate,color=purple!20](O,A)(30)
 \tkzFillSector[rotate,color=teal!40](O,A)(-30)
\end{tikzpicture}
```

### 27.5. Colour an angle: \tkzFillAngle

The simplest operation

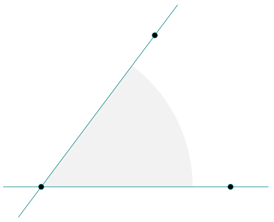
`\tkzFillAngle[⟨local options⟩](⟨A,O,B⟩)`

O is the vertex of the angle. OA and OB are the sides. Attention the angle is determined by the order of the points.

| options | default | definition |
|---|---|---|
| size | 1 | this option determines the radius of the coloured angular sector. |

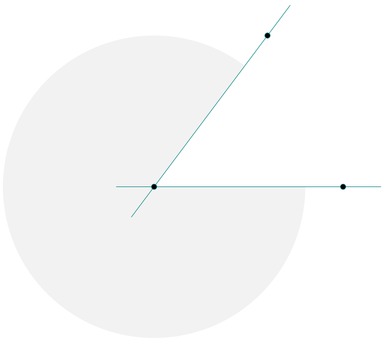
Of course, you have to add all the styles of Ti*k*Z, like the use of fill and shade...

### 27.5.1. Example with size

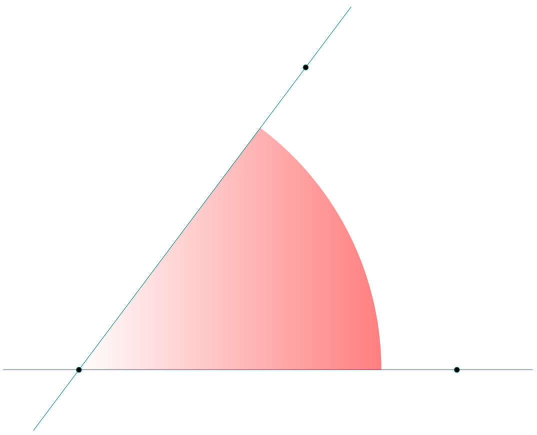


```
\begin{tikzpicture}
   \tkzInit
   \tkzDefPoints{0/0/O,2.5/0/A,1.5/2/B}
   \tkzFillAngle[size=2, fill=gray!10](A,O,B)
   \tkzDrawLines(O,A O,B)
   \tkzDrawPoints(O,A,B)
\end{tikzpicture}
```

### 27.5.2. Changing the order of items



```
\begin{tikzpicture}
   \tkzInit
   \tkzDefPoints{0/0/O,2.5/0/A,1.5/2/B}
   \tkzFillAngle[size=2,fill=gray!10](B,O,A)
   \tkzDrawLines(O,A O,B)
   \tkzDrawPoints(O,A,B)
\end{tikzpicture}
```

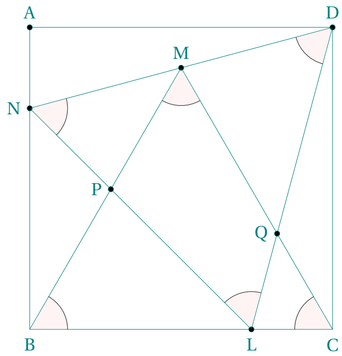


```
\begin{tikzpicture}
   \tkzInit
   \tkzDefPoints{0/0/O,5/0/A,3/4/B}
   % Don't forget {} to get, () to use
   \tkzFillAngle[size=4,left color=white,
                 right color=red!50](A,O,B)
   \tkzDrawLines(O,A O,B)
   \tkzDrawPoints(O,A,B)
\end{tikzpicture}
```

`\tkzFillAngles[⟨local options⟩](⟨A,O,B⟩)(⟨A',O',B'⟩)etc.`

With common options, there is a macro for multiple angles.

### 27.5.3. Multiples angles




```
\begin{tikzpicture}[scale=0.5]
  \tkzDefPoints{0/0/B,8/0/C,0/8/A,8/8/D}
  \tkzDrawPolygon(B,C,D,A)
  \tkzDefTriangle[equilateral](B,C) \tkzGetPoint{M}
  \tkzInterLL(D,M)(A,B) \tkzGetPoint{N}
  \tkzDefPointBy[rotation=center N angle -60](D)
  \tkzGetPoint{L}
  \tkzInterLL(N,L)(M,B)     \tkzGetPoint{P}
  \tkzInterLL(M,C)(D,L)     \tkzGetPoint{Q}
  \tkzDrawSegments(D,N N,L L,D B,M M,C)
  \tkzDrawPoints(L,N,P,Q,M,A,D)
  \tkzLabelPoints[left](N,P,Q)
  \tkzLabelPoints[above](M,A,D)
  \tkzLabelPoints(L,B,C)
  \tkzMarkAngles(C,B,M B,M,C M,C,B D,L,N L,N,D N,D,L)
  \tkzFillAngles[fill=red!20,opacity=.2](C,B,M%
      B,M,C M,C,B D,L,N L,N,D N,D,L)
\end{tikzpicture}
```

## 28. Controlling Bounding Box

From the PgfManual :
"When you add the clip option, the current path is used for clipping subsequent drawings. Clipping never enlarges the clipping area. Thus, when you clip against a certain path and then clip again against another path, you clip against the intersection of both. The only way to enlarge the clipping path is to end the pgfscope in which the clipping was done. At the end of a pgfscope the clipping path that was in force at the beginning of the scope is reinstalled."
First of all, you don't have to deal with Ti*k*Z the size of the bounding box. Early versions of tkz-euclide did not control the size of the bounding box, now with tkz-euclide 4 the size of the bounding box is limited.
The initial bounding box after using the macro \tkzInit is defined by the rectangle based on the points $(0,0)$ and $(10,10)$. The \tkzInit macro allows this initial bounding box to be modified using the arguments (**xmin**, **xmax**, **ymin**, and **ymax**). Of course any external trace modifies the bounding box. Ti*k*Z maintains that bounding box. It is possible to influence this behavior either directly with commands or options in Ti*k*Z such as a command like \useasboundingbox or the option **use as bounding box**. A possible consequence is to reserve a box for a figure but the figure may overflow the box and spread over the main text. The following command \pgfresetboundingbox clears a bounding box and establishes a new one.

### 28.1. Utility of \tkzInit

However, it is sometimes necessary to control the size of what will be displayed. To do this, you need to have prepared the bounding box you are going to work in, this is the role of the macro \tkzInit. For some drawings, it is interesting to fix the extreme values (xmin,xmax,ymin and ymax) and to clip the definition rectangle in order to control the size of the figure as well as possible.
The two macros that are useful for controlling the bounding box:

– \tkzInit

– \tkzClip

To this, I added macros directly linked to the bounding box. You can now view it, backup it, restore it (see the section Bounding Box).

### 28.2. \tkzInit

\tkzInit[⟨local options⟩]

| options | default | definition |
|---|---|---|
| xmin | 0 | minimum value of the abscissae in cm |
| xmax | 10 | maximum value of the abscissae in cm |
| xstep | 1 | difference between two graduations in x |
| ymin | 0 | minimum y-axis value in cm |
| ymax | 10 | maximum y-axis value in cm |
| ystep | 1 | difference between two graduations in y |

The role of `\tkzInit` is to define a orthogonal coordinates system and a rectangular part of the plane in which you will place your drawings using Cartesian coordinates. This macro allows you to define your working environment as with a calculator. With **tkz-euclide** 4 `\xstep` and `\ystep` are always 1. Logically it is no longer useful to use `\tkzInit`, except for an action like `Clipping Out`.

### 28.3. \tkzClip

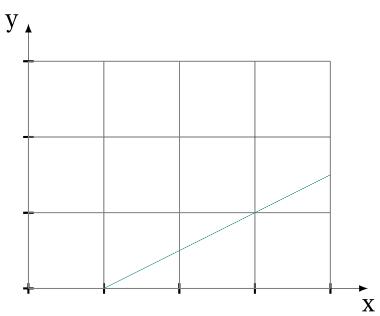
\tkzClip[⟨local options⟩]

The role of this macro is to make invisible what is outside the rectangle defined by (xmin ; ymin) and (xmax ; ymax).

| options | default | definition |
|---|---|---|
| space | 1 | added value on the right, left, bottom and top of the background |

The role of the `space` option is to enlarge the visible part of the drawing. This part becomes the rectangle defined by (xmin-space ; ymin-space) and (xmax+space ; ymax+space). `space` can be negative! The unit is cm and should not be specified.

The role of this macro is to `clip` the initial rectangle so that only the paths contained in this rectangle are drawn.



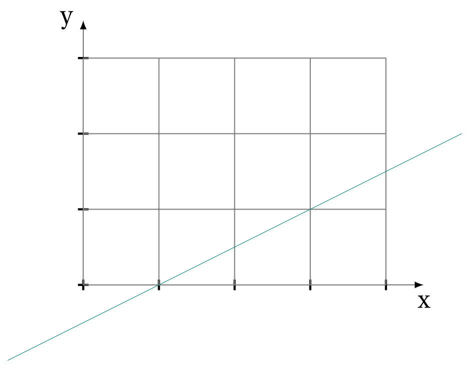

```
\begin{tikzpicture}
 \tkzInit[xmax=4, ymax=3]
 \tkzDefPoints{-1/-1/A,5/2/B}
 \tkzDrawX \tkzDrawY
 \tkzGrid
 \tkzClip
 \tkzDrawSegment(A,B)
\end{tikzpicture}
```

It is possible to add a bit of space

```
\tkzClip[space=1]
```

### 28.4. \tkzClip and the option space

This option allows you to add some space around the `clipped` rectangle.




```
\begin{tikzpicture}
 \tkzInit[xmax=4, ymax=3]
 \tkzDefPoints{-1/-1/A,5/2/B}
 \tkzDrawX \tkzDrawY
 \tkzGrid
 \tkzClip[space=1]
 \tkzDrawSegment(A,B)
\end{tikzpicture}
```

The dimensions of the `clipped` rectangle are **`xmin-1`**, **`ymin-1`**, **`xmax+1`** and **`ymax+1`**.

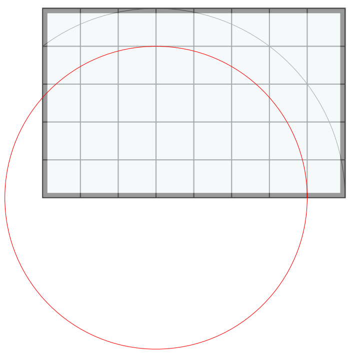
## 28.5. tkzShowBB

The simplest macro.

`\tkzShowBB[⟨local options⟩]`

This macro displays the bounding box. A rectangular frame surrounds the bounding box. This macro accepts TikZ options.

### 28.5.1. Example with \tkzShowBB



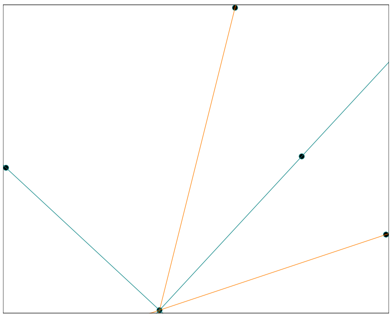
```
\begin{tikzpicture}[scale=.5]
  \tkzInit[ymax=5,xmax=8]
  \tkzGrid
  \tkzDefPoint(3,0){A}
   \begin{scope}
    \tkzClipBB
    \tkzDefCircle[R](A,5) \tkzGetPoint{a}
    \tkzDrawCircle(A,a)
    \tkzShowBB[line width = 4pt,fill=teal!10,%
              opacity=.4]
   \end{scope}
\tkzDefCircle[R](A,4) \tkzGetPoint{b}
\tkzDrawCircle[red](A,b)
\end{tikzpicture}
```

## 28.6. tkzClipBB

`\tkzClipBB`

The idea is to limit future constructions to the current bounding box.

### 28.6.1. Example with \tkzClipBB and the bisectors



```
\begin{tikzpicture}
\tkzInit[xmin=-3,xmax=6, ymin=-1,ymax=6]
\tkzDefPoint(0,0){O}\tkzDefPoint(3,1){I}
\tkzDefPoint(1,4){J}
\tkzDefLine[bisector](I,O,J) \tkzGetPoint{i}
\tkzDefLine[bisector out](I,O,J) \tkzGetPoint{j}
\tkzDrawPoints(O,I,J,i,j)
\tkzClipBB
\tkzDrawLines[add = 1 and 2,color=orange](O,I O,J)
\tkzDrawLines[add = 1 and 2](O,i O,j)
\tkzShowBB
\end{tikzpicture}
```

# 29. Clipping different objects

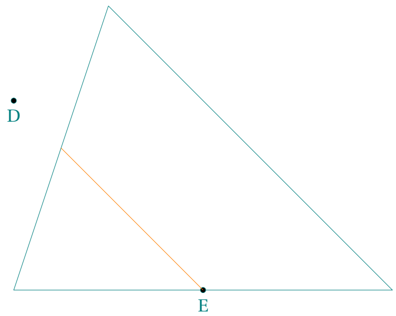
## 29.1. Clipping a polygon

\tkzClipPolygon[⟨local options⟩](⟨points list⟩)

This macro makes it possible to contain the different plots in the designated polygon.

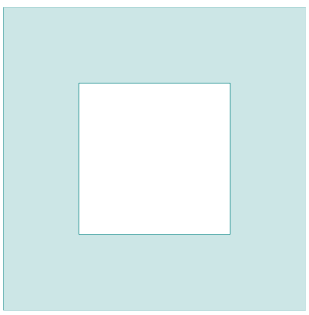
| arguments | example | explanation |
|---|---|---|
| (⟨pt1,pt2,pt3,…⟩) | (⟨A,B,C⟩) | |
| **options** | **default** | **definition** |
| out | | allows to clip the outside of the object |

### 29.1.1. \tkzClipPolygon



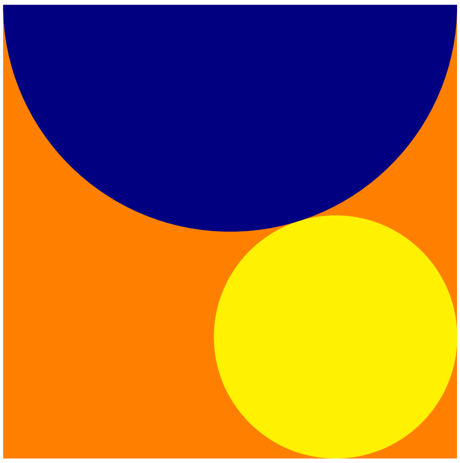

```
\begin{tikzpicture}[scale=1.25]
\tkzDefPoint(0,0){A}
\tkzDefPoint(4,0){B}
\tkzDefPoint(1,3){C}
\tkzDrawPolygon(A,B,C)
\tkzDefPoint(0,2){D}
\tkzDefPoint(2,0){E}
\tkzDrawPoints(D,E)
\tkzLabelPoints(D,E)
\tkzClipPolygon(A,B,C)
\tkzDrawLine[new](D,E)
\end{tikzpicture}
```

### 29.1.2. \tkzClipPolygon[out]



```
\begin{tikzpicture}[scale=1]
\tkzDefPoint(0,0){P1}
\tkzDefPoint(4,0){P2}
\tkzDefPoint(4,4){P3}
\tkzDefPoint(0,4){P4}
\tkzDefPoint(1,1){Q1}
\tkzDefPoint(3,1){Q2}
\tkzDefPoint(3,3){Q3}
\tkzDefPoint(1,3){Q4}
\tkzDrawPolygon(P1,P2,P3,P4)
\begin{scope}
   \tkzClipPolygon[out](Q1,Q2,Q3,Q4)
  \tkzFillPolygon[teal!20](P1,P2,P3,P4)
\end{scope}
\tkzDrawPolygon(Q1,Q2,Q3,Q4)
\end{tikzpicture}
```

### 29.1.3. Example: use of Clip for Sangaku in a square



```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoint(0,0){A} \tkzDefPoint(8,0){B}
 \tkzDefSquare(A,B)    \tkzGetPoints{C}{D}
 \tkzDefPoint(4,8){F}
 \tkzDefTriangle[equilateral](C,D)
 \tkzGetPoint{I}
 \tkzDefPointBy[projection=onto B--C](I)
 \tkzGetPoint{J}
 \tkzInterLL(D,B)(I,J)   \tkzGetPoint{K}
 \tkzDefPointBy[symmetry=center K](B)
 \tkzGetPoint{M}
 \tkzClipPolygon(B,C,D,A)
 \tkzFillPolygon[color = orange](A,B,C,D)
 \tkzFillCircle[color = yellow](M,I)
 \tkzFillCircle[color = blue!50!black](F,D)
\end{tikzpicture}
```

## 29.2. Clipping a disc

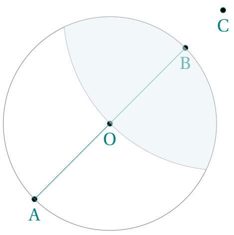
**\tkzClipCircle[⟨local options⟩](⟨A,B⟩)**

| arguments | example | explanation |
|---|---|---|
| (⟨A,B⟩) | (⟨A,B⟩) | AB radius |

| options | default | definition |
|---|---|---|
| out | | allows to clip the outside of the object |

It is not necessary to put **radius** because that is the default option.

### 29.2.1. Simple clip




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoint(0,0){A} \tkzDefPoint(2,2){O}
  \tkzDefPoint(4,4){B} \tkzDefPoint(5,5){C}
  \tkzDrawPoints(O,A,B,C)
  \tkzLabelPoints(O,A,B,C)
  \tkzDrawCircle(O,A)
  \tkzClipCircle(O,A)
  \tkzDrawLine(A,C)
  \tkzDrawCircle[fill=teal!10,opacity=.5](C,O)
\end{tikzpicture}
```

### 29.3. Clip out

```
\begin{tikzpicture}
  \tkzInit[xmin=-3,ymin=-2,xmax=4,ymax=3]
   \tkzDefPoint(0,0){O}
   \tkzDefPoint(-4,-2){A}
   \tkzDefPoint(3,1){B}
   \tkzDefCircle[R](O,2) \tkzGetPoint{o}
   \tkzDrawPoints(A,B) % to have a good bounding box
   \begin{scope}
    \tkzClipCircle[out](O,o)
    \tkzDrawLines(A,B)
   \end{scope}
\end{tikzpicture}
```

### 29.4. Intersection of disks

```
\begin{tikzpicture}
\tkzDefPoints{0/0/O,4/0/A,0/4/B}
\tkzDrawPolygon[fill=teal](O,A,B)
\tkzClipPolygon(O,A,B)
\tkzClipCircle(A,O)
\tkzClipCircle(B,O)
\tkzFillPolygon[white](O,A,B)
\end{tikzpicture}
```

see a more complex example about clipping here : 47.6

### 29.5. Clipping a sector

Attention the arguments vary according to the options.

`\tkzClipSector[⟨local options⟩](⟨O,...⟩)(⟨...⟩)`

| options | default | definition |
|---|---|---|
| towards | towards | O is the center and the sector starts from A to (OB) |
| rotate | towards | The sector starts from A and the angle determines its amplitude. |
| R | towards | We give the radius and two angles |

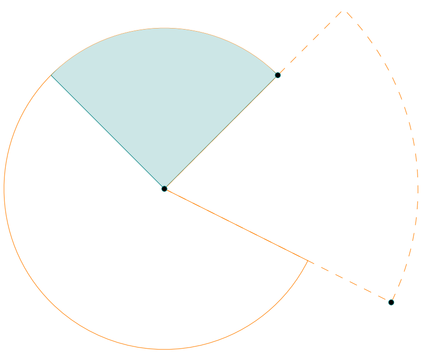
You have to add, of course, all the styles of Ti*k*Z for tracings...

| options | arguments | example |
|---|---|---|
| towards | (⟨pt,pt⟩)(⟨pt⟩) | `\tkzClipSector(O,A)(B)` |
| rotate | (⟨pt,pt⟩)(⟨angle⟩) | `\tkzClipSector[rotate](O,A)(90)` |
| R | (⟨pt,r⟩)(⟨angle 1,angle 2⟩) | `\tkzClipSector[R](O,2)(30,90)` |

### 29.5.1. Example 1

```
\begin{tikzpicture}[scale=0.5]
\tkzDefPoint(0,0){a}
\tkzDefPoint(12,0){b}
\tkzDefPoint(4,10){c}
\tkzInterCC[R](a,6)(b,8)
\tkzGetFirstPoint{AB1} \tkzGetSecondPoint{AB2}
\tkzInterCC[R](a,6)(c,6)
\tkzGetFirstPoint{AC1} \tkzGetSecondPoint{AC2}
\tkzInterCC[R](b,8)(c,6)
\tkzGetFirstPoint{BC1} \tkzGetSecondPoint{BC2}
\tkzDrawArc(a,AB2)(AB1)
\tkzDrawArc(b,AB1)(AB2)
\tkzDrawArc(a,AC2)(AC1)
\tkzDrawArc(c,AC1)(AC2)
\tkzDrawArc(b,BC2)(BC1)
\tkzDrawArc(c,BC1)(BC2)
\begin{scope}
\tkzClipSector(b,BC2)(BC1)
\tkzFillSector[teal!40!white](c,BC1)(BC2)
\end{scope}
\begin{scope}
\tkzClipSector(a,AB2)(AB1)
\tkzFillSector[teal!40!white](b,AB1)(AB2)
\end{scope}
\begin{scope}
\tkzClipSector(a,AC2)(AC1)
\tkzFillSector[teal!40!white](c,AC1)(AC2)
\end{scope}
\end{tikzpicture}
```

### 29.5.2. Example 2



```
\begin{tikzpicture}[scale=1.5]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2,-1){A}
  \tkzDefPoint(1,1){B}
  \tkzDrawSector[new,dashed](O,A)(B)
  \tkzDrawSector[new](O,B)(A)
\begin{scope}
\tkzClipSector(O,B)(A)
\tkzDefSquare(O,B) \tkzGetPoints{B'}{O'}
\tkzDrawPolygon[color=teal,fill=teal!20](O,B,B',O')
\end{scope}
\tkzDrawPoints(A,B,O)
\end{tikzpicture}
```

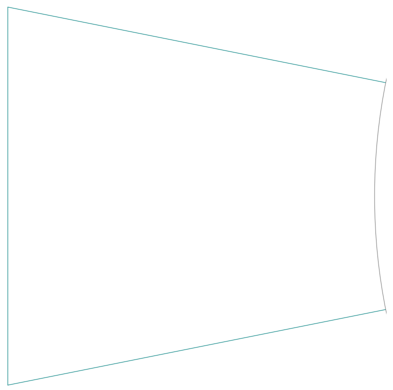
## 29.6. Options from TikZ: trim left or right

See the `pgfmanual`

## 29.7. TikZ Controls \pgfinterruptboundingbox and \endpgfinterruptboundingbox

This command temporarily interrupts the calculation of the box and configures a new box. See the `pgfmanual`

#### 29.7.1. Example about contolling the bouding box



```
\begin{tikzpicture}
\tkzDefPoint(0,5){A}\tkzDefPoint(5,4){B}
\tkzDefPoint(0,0){C}\tkzDefPoint(5,1){D}
\tkzDrawSegments(A,B C,D A,C)
\pgfinterruptboundingbox
   \tkzInterLL(A,B)(C,D)\tkzGetPoint{I}
\endpgfinterruptboundingbox
\tkzClipBB
\tkzDrawCircle(I,B)
\end{tikzpicture}
```

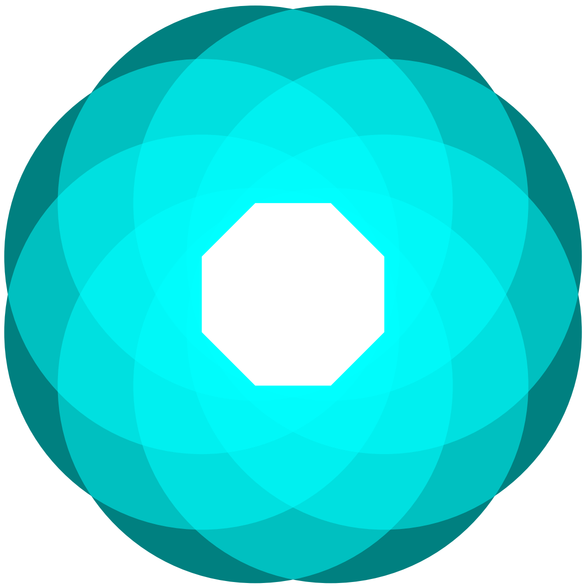
### 29.8. Reverse clip: tkzreverseclip

In order to use this option, a bounding box must be defined.

```
\tikzset{tkzreverseclip/.style={insert path={
   (current bounding box.south west) --(current bounding box.north west)
 --(current bounding box.north east) --  (current bounding box.south east)
 -- cycle} }}
```

#### 29.8.1. Example with \tkzClipPolygon[out]

`\tkzClipPolygon[out]`, `\tkzClipCircle[out]` use this option.



```
\begin{tikzpicture}[scale=1]
\tkzInit[xmin=-5,xmax=5,ymin=-4,ymax=6]
\tkzClip
\tkzDefPoints{-.5/0/P1,.5/0/P2}
\foreach \i [count=\j from 3] in {2,...,7}{%
    \tkzDefShiftPoint[P\i]({45*(\i-1)}:1){P\j}}
\tkzClipPolygon[out](P1,P...,P8)
\tkzCalcLength(P1,P5)\tkzGetLength{r}
\begin{scope}[blend group=screen]
  \foreach \i in {1,...,8}{%
   \tkzDefCircle[R](P\i,\r) \tkzGetPoint{x}
   \tkzFillCircle[color=teal](P\i,x)}
  \end{scope}
\end{tikzpicture}
```

# Part V.

# Marking

### 29.9. Mark a segment \tkzMarkSegment

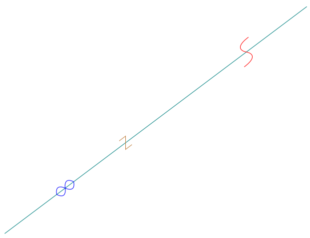
```
\tkzMarkSegment[⟨local options⟩](⟨pt1,pt2⟩)
```

The macro allows you to place a mark on a segment.

| options | default | definition |
|---|---|---|
| pos | .5 | position of the mark |
| color | black | color of the mark |
| mark | none | choice of the mark |
| size | 4pt | size of the mark |

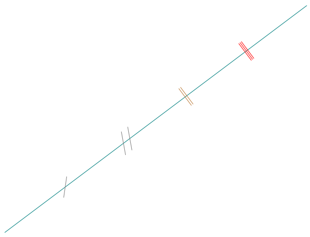
Possible marks are those provided by TikZ, but other marks have been created based on an idea by Yves Combe.

#### 29.9.1. Several marks



```
\begin{tikzpicture}
  \tkzDefPoint(2,1){A}
  \tkzDefPoint(6,4){B}
  \tkzDrawSegment(A,B)
  \tkzMarkSegment[color=brown,size=2pt,pos=0.4, mark=z](A,B)
  \tkzMarkSegment[color=blue,pos=0.2, mark=oo](A,B)
  \tkzMarkSegment[pos=0.8,mark=s,color=red](A,B)
\end{tikzpicture}
```

#### 29.9.2. Use of mark



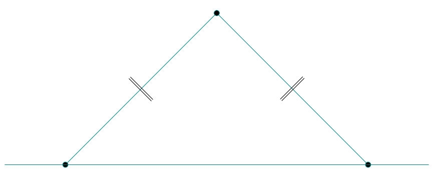
```
\begin{tikzpicture}
  \tkzDefPoint(2,1){A}
  \tkzDefPoint(6,4){B}
  \tkzDrawSegment(A,B)
  \tkzMarkSegment[color=gray,pos=0.2,mark=s|](A,B)
  \tkzMarkSegment[color=gray,pos=0.4,mark=s||](A,B)
  \tkzMarkSegment[color=brown,pos=0.6,mark=||](A,B)
  \tkzMarkSegment[color=red,pos=0.8,mark=|||](A,B)
\end{tikzpicture}
```

### 29.10. Marking segments \tkzMarkSegments

```
\tkzMarkSegments[⟨local options⟩](⟨pt1,pt2 pt3,pt4 ...⟩)
```

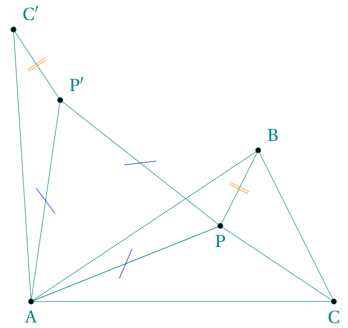
Arguments are a list of pairs of points separated by spaces. The styles of TikZ are available for plots.

#### 29.10.1. Marks for an isosceles triangle



```
\begin{tikzpicture}[scale=1]
 \tkzDefPoints{0/0/O,2/2/A,4/0/B,6/2/C}
 \tkzDrawSegments(O,A A,B)
 \tkzDrawPoints(O,A,B)
 \tkzDrawLine(O,B)
 \tkzMarkSegments[mark=||,size=6pt](O,A A,B)
\end{tikzpicture}
```

### 29.11. Another marking




```
\begin{tikzpicture}[scale=1]
 \tkzDefPoint(0,0){A}\tkzDefPoint(3,2){B}
 \tkzDefPoint(4,0){C}\tkzDefPoint(2.5,1){P}
 \tkzDrawPolygon(A,B,C)
 \tkzDefEquilateral(A,P) \tkzGetPoint{P'}
 \tkzDefPointsBy[rotation=center A angle 60](P,B){P',C'}
 \tkzDrawPolygon(A,P,P')
 \tkzDrawPolySeg(P',C',A,P,B)
 \tkzDrawSegment(C,P)
 \tkzDrawPoints(A,B,C,C',P,P')
 \tkzMarkSegments[mark=s|,size=6pt,
 color=blue](A,P P,P' P',A)
 \tkzMarkSegments[mark=||,color=orange](B,P P',C')
 \tkzLabelPoints(A,C) \tkzLabelPoints[below](P)
 \tkzLabelPoints[above right](P',C',B)
\end{tikzpicture}
```

### 29.12. Mark an arc \tkzMarkArc

\tkzMarkArc[⟨local options⟩](⟨pt1,pt2,pt3⟩)

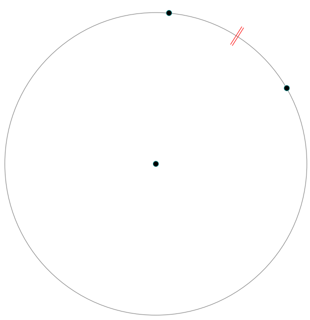
The macro allows you to place a mark on an arc. pt1 is the center, pt2 and pt3 are the endpoints of the arc.

| options | default | definition |
|---|---|---|
| pos | .5 | position of the mark |
| color | black | color of the mark |
| mark | none | choice of the mark |
| size | 4pt | size of the mark |

Possible marks are those provided by Ti*k*Z, but other marks have been created based on an idea by Yves Combe.

`|, ||,|||, z, s, x, o, oo`

#### 29.12.1. Several marks



```
\begin{tikzpicture}
\tkzDefPoint(0,0){O}
\pgfmathsetmacro\r{2}
\tkzDefPoint(30:\r){A}
\tkzDefPoint(85:\r){B}
\tkzDrawCircle(O,A)
\tkzMarkArc[color=red,mark=||](O,A,B)
\tkzDrawPoints(B,A,O)
\end{tikzpicture}
```

### 29.13. Mark an angle mark : \tkzMarkAngle

More delicate operation because there are many options. The symbols used for marking in addition to those of Ti*k*Z are defined in the file `tkz-lib-marks.tex` and designated by the following characters:

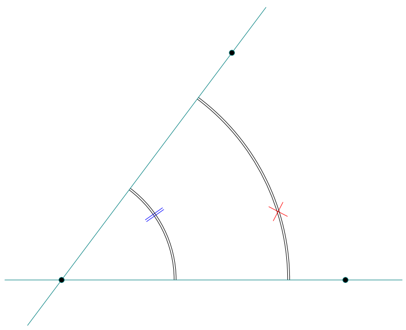
`|, ||,|||, z, s, x, o, oo`

`\tkzMarkAngle[⟨local options⟩](⟨A,O,B⟩)`

O is the vertex. Attention the arguments vary according to the options. Several markings are possible. You can simply draw an arc or add a mark on this arc. The style of the arc is chosen with the option **arc**, the radius of the arc is given by **mksize**, the arc can, of course, be colored.

| options | default | definition |
|---|---|---|
| arc | l | choice of l, ll and lll (single, double or triple). |
| size | 1 (cm) | arc radius. |
| mark | none | choice of mark. |
| mksize | 4pt | symbol size (mark). |
| mkcolor | black | symbol color (mark). |
| mkpos | 0.5 | position of the symbol on the arc. |

### 29.13.1. Example with mark = x and with mark =||



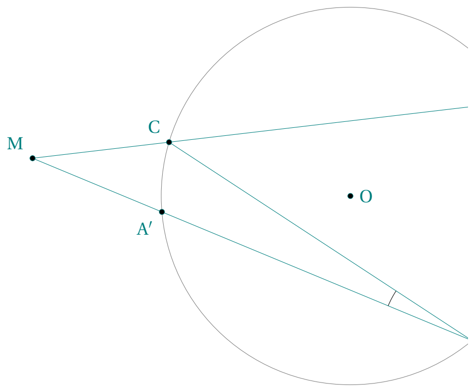
```
\begin{tikzpicture}[scale=.75]
    \tkzDefPoints{0/0/O,5/0/A,3/4/B}
    \tkzMarkAngle[size = 4,mark = x,
                 arc=ll,mkcolor = red,mkpos=.33](A,O,B)
    \tkzMarkAngle[size = 2,mark = ||,
               arc=ll,mkcolor = blue,mkpos=.66](A,O,B)
    \tkzDrawLines(O,A O,B)
    \tkzDrawPoints(O,A,B)
\end{tikzpicture}
```

`\tkzMarkAngles[⟨local options⟩](⟨A,O,B⟩)(⟨A',O',B'⟩)etc.`

With common options, there is a macro for multiple angles.

### 29.14. Problem to mark a small angle: Option veclen

The problem comes from the ”decorate” action and from the value used in size in `\tkzMarkAngle`. The solution is to enclose the macro `\tkzMarkAngle`. In the next example without the ”scope” the result is : Latex Error: Dimension too large.




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2.5,0){N}
  \tkzDefPoint(-4.2,0.5){M}
  \tkzDefPointBy[rotation=center O angle 30](N)
  \tkzGetPoint{B}
  \tkzDefPointBy[rotation=center O angle -50](N)
  \tkzGetPoint{A}
  \tkzInterLC[common=B](M,B)(O,B) \tkzGetFirstPoint{C}
  \tkzInterLC[common=A](M,A)(O,A) \tkzGetFirstPoint{A'}
  \tkzDrawSegments(A,C M,A M,B A,B)
  \tkzDrawCircle(O,N)
  \begin{scope}[veclen]
    \tkzMarkAngle[mkpos=.2, size=1.2](C,A,M)
  \end{scope}
  \tkzDrawPoints(O, A, B, M, B, C, A')
  \tkzLabelPoints[right](O,A,B)
  \tkzLabelPoints[above left](M,C)
  \tkzLabelPoint[below left](A'){$A'$}
\end{tikzpicture}
```

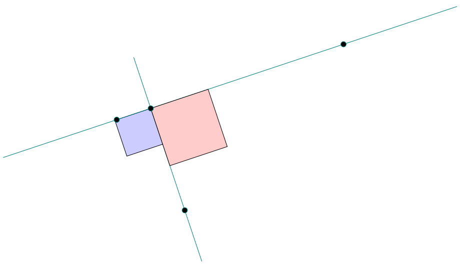
### 29.15. Marking a right angle: \tkzMarkRightAngle

**\tkzMarkRightAngle[⟨local options⟩](⟨A,O,B⟩)**

The **german** option allows you to change the style of the drawing. The option **size** allows to change the size of the drawing.

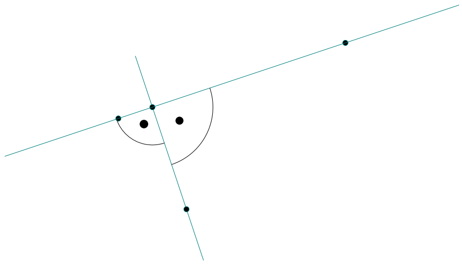
| options | default | definition |
|---|---|---|
| german | normal | german arc with inner point. |
| size | 0.2 | side size. |

#### 29.15.1. Example of marking a right angle



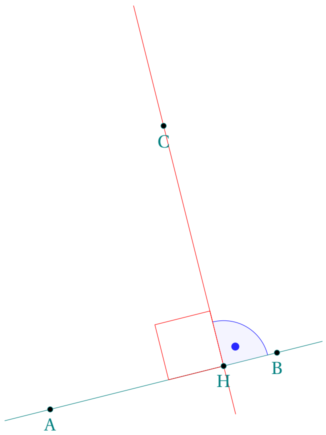
```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,3/1/B,0.9/-1.2/P}
  \tkzDefPointBy[projection = onto B--A](P)  \tkzGetPoint{H}
  \tkzDrawLines[add=.5 and .5](P,H)
  \tkzMarkRightAngle[fill=blue!20,size=.5,draw](A,H,P)
  \tkzDrawLines[add=.5 and .5](A,B)
  \tkzMarkRightAngle[fill=red!20,size=.8](B,H,P)
  \tkzDrawPoints[](A,B,P,H)
\end{tikzpicture}
```

### 29.15.2. Example of marking a right angle, german style



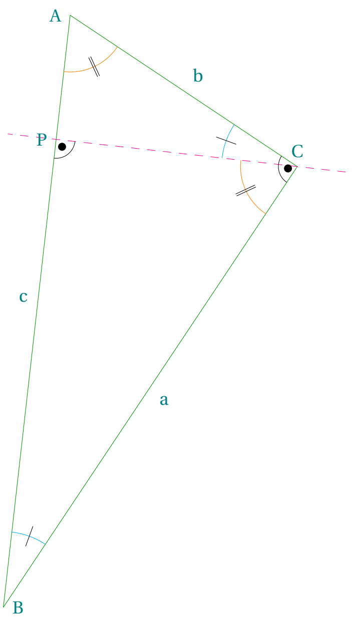
```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,3/1/B,0.9/-1.2/P}
  \tkzDefPointBy[projection = onto B--A](P)  \tkzGetPoint{H}
  \tkzDrawLines[add=.5 and .5](P,H)
  \tkzMarkRightAngle[german,size=.5,draw](A,H,P)
  \tkzDrawPoints[](A,B,P,H)
  \tkzDrawLines[add=.5 and .5](A,B)
  \tkzMarkRightAngle[german,size=.8](P,H,B)
\end{tikzpicture}
```

### 29.15.3. Mix of styles




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(4,1){B}
  \tkzDefPoint(2,5){C}
  \tkzDefPointBy[projection=onto B--A](C)
      \tkzGetPoint{H}
  \tkzDrawLine(A,B)
  \tkzDrawLine[add = .5 and .2,color=red](C,H)
  \tkzMarkRightAngle[,size=1,color=red](C,H,A)
  \tkzMarkRightAngle[german,size=.8,color=blue](B,H,C)
  \tkzFillAngle[opacity=.2,fill=blue!20,size=.8](B,H,C)
  \tkzLabelPoints(A,B,C,H)
  \tkzDrawPoints(A,B,C,H)
\end{tikzpicture}
```

#### 29.15.4. Full example




```
\begin{tikzpicture}[rotate=-90]
\tkzDefPoint(0,1){A}
\tkzDefPoint(2,4){C}
\tkzDefPointWith[orthogonal normed,K=7](C,A)
\tkzGetPoint{B}
\tkzDrawSegment[green!60!black](A,C)
\tkzDrawSegment[green!60!black](C,B)
\tkzDrawSegment[green!60!black](B,A)
\tkzDefSpcTriangle[orthic](A,B,C){N,O,P}
\tkzDrawLine[dashed,color=magenta](C,P)
\tkzLabelPoint[left](A){$A$}
\tkzLabelPoint[right](B){$B$}
\tkzLabelPoint[above](C){$C$}
\tkzLabelPoint[left](P){$P$}
\tkzLabelSegment[auto](B,A){$c$}
\tkzLabelSegment[auto,swap](B,C){$a$}
\tkzLabelSegment[auto,swap](C,A){$b$}
\tkzMarkAngle[size=1,color=cyan,mark=|](C,B,A)
\tkzMarkAngle[size=1,color=cyan,mark=|](A,C,P)
\tkzMarkAngle[size=0.75,color=orange,
    mark=||](P,C,B)
\tkzMarkAngle[size=0.75,color=orange,
   mark=||](B,A,C)
\tkzMarkRightAngle[german](A,C,B)
\tkzMarkRightAngle[german](B,P,C)
\end{tikzpicture}
```

### 29.16. \tkzMarkRightAngles

`\tkzMarkRightAngles[⟨local options⟩](⟨A,O,B⟩)(⟨A',O',B'⟩)etc.`

With common options, there is a macro for multiple angles.

### 29.17. Angles Library

If you prefer to use Ti*k*Z library `angles`, you can mark angles with the macro `\tkzPicAngle` and `\tkzPicRightAngle`.

`\tkzPicAngle[⟨tikz options⟩](⟨A,O,B⟩)`

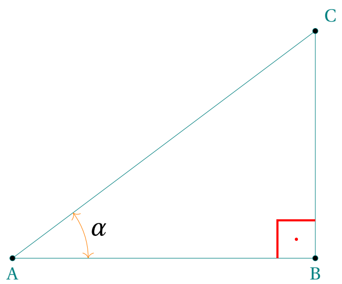
| options | example | definition |
|---|---|---|
| `tikz option` | `see below` | `drawing of the angle` $\widehat{AOB}$. |

`\tkzPicRightAngle[⟨tikz options⟩](⟨A,O,B⟩)`

| options | example | definition |
|---|---|---|
| `tikz option` | `see below` | `drawing of the right angle` $\widehat{AOB}$. |

*You need to know possible options of the* `angles` *library*

### 29.17.1. Angle with TikZ




```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,4/0/B}
\tkzDefTriangle[right,swap](A,B) \tkzGetPoint{C}
\tkzDrawPolygon(A,B,C)
\tkzDrawPoints(A,B,C)
\tkzLabelPoints[below](B,A)
\tkzLabelPoints[above right](C)
\tkzPicAngle["$\alpha$",draw=orange,
             <->,angle eccentricity=1.2,
             angle radius=1cm](B,A,C)
\tkzPicRightAngle[draw,red,thick,
              angle eccentricity=.5,
              pic text=.](C,B,A)
\end{tikzpicture}
```

# Part VI.

# Labelling

# 30. Labelling

## 30.1. Label for a point

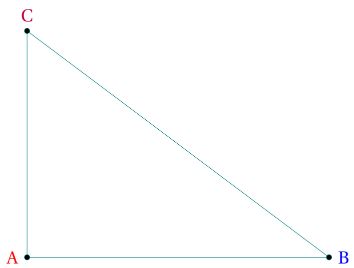
It is possible to add several labels at the same point by using this macro several times.

\tkzLabelPoint[⟨local options⟩](⟨point⟩){⟨label⟩}

| arguments | example | |
|---|---|---|
| point | \tkzLabelPoint(A){$A_1$} | |
| options | default | definition |
| TikZ options | | colour, position etc. |

Optionally, we can use any style of TikZ, especially placement with above, right, dots...

### 30.1.1. Example with \tkzLabelPoint




```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(4,0){B}
  \tkzDefPoint(0,3){C}
  \tkzDrawSegments(A,B B,C C,A)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoint[left,red](A){$A$}
  \tkzLabelPoint[right,blue](B){$B$}
  \tkzLabelPoint[above,purple](C){$C$}
\end{tikzpicture}
```

### 30.1.2. Label and reference

The reference of a point is the object that allows to use the point, the label is the name of the point that will be displayed.


```
\begin{tikzpicture}
   \tkzDefPoint(2,0){A}
   \tkzDrawPoint(A)
   \tkzLabelPoint[above](A){$A_1$}
 \end{tikzpicture}
```

## 30.2. Add labels to points \tkzLabelPoints

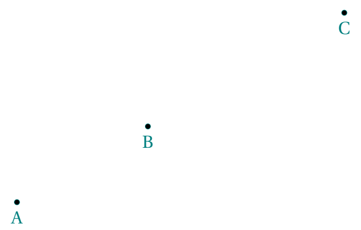
It is possible to place several labels quickly when the point references are identical to the labels and when the labels are placed in the same way in relation to the points. By default, `below right` is chosen.

\tkzLabelPoints[⟨local options⟩](⟨$A_1$,$A_2$,...⟩)

| arguments | example | result |
|---|---|---|
| list of points | \tkzLabelPoints(A,B,C) | Display of A, B and C |

This macro reduces the number of lines of code, but it is not obvious that all points need the same label positioning.

#### 30.2.1. Example with \tkzLabelPoints




```
\begin{tikzpicture}
  \tkzDefPoint(2,3){A}
  \tkzDefShiftPoint[A](30:2){B}
  \tkzDefShiftPoint[A](30:5){C}
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,B,C)
\end{tikzpicture}
```

### 30.3. Automatic position of labels \tkzAutoLabelPoints

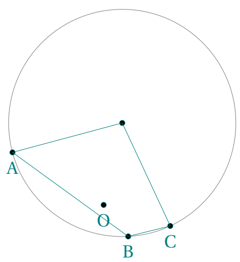
The label of a point is placed in a direction defined by a center and a point **center**. The distance to the point is determined by a percentage of the distance between the center and the point. This percentage is given by **dist**.

**\tkzLabelPoints[⟨local options⟩](⟨$A_1$,$A_2$,...⟩)**

| arguments | example | result |
|---|---|---|
| list of points | \tkzLabelPoint(A,B,C) | Display of A, B and C |

#### 30.3.1. Label for points with \tkzAutoLabelPoints

Here the points are positioned relative to the center of gravity of A, B, C and O.




```
\begin{tikzpicture}[scale=1]
 \tkzDefPoint(2,1){O}
 \tkzDefRandPointOn[circle=center O radius 1.5]\tkzGetPoint{A}
 \tkzDefPointBy[rotation=center O angle 100](A)\tkzGetPoint{C}
 \tkzDefPointBy[rotation=center O angle 78](A)\tkzGetPoint{B}
 \tkzDrawCircle(O,A)
 \tkzDrawPoints(O,A,B,C)
 \tkzDrawSegments(C,B B,A A,O O,C)
 \tkzDefTriangleCenter[centroid](A,B,C) \tkzGetPoint{O}
 \tkzDrawPoint(tkzPointResult)
 \tkzLabelPoints(O,A,C,B)
\end{tikzpicture}
```

## 31. Label for a segment

**\tkzLabelSegment[⟨local options⟩](⟨pt1,pt2⟩){⟨label⟩}**

This macro allows you to place a label along a segment or a line. The options are those of Ti*k*Z for example **pos**.

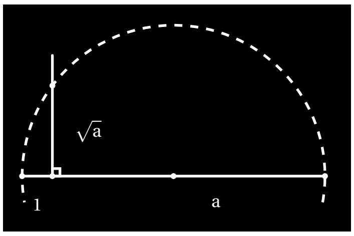
| argument | example | definition |
|---|---|---|
| label | \tkzLabelSegment(A,B){5} | label text |
| (pt1,pt2) | (A,B) | label along [AB] |

| options | default | definition |
|---|---|---|
| pos | .5 | label's position |

### 31.0.1. First example

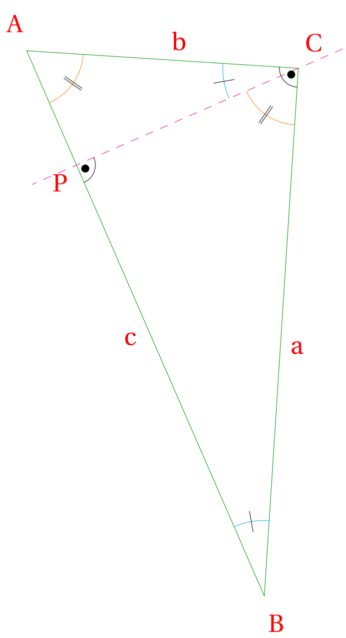

```
\begin{tikzpicture}
\tkzDefPoint(0,0){A}
\tkzDefPoint(6,0){B}
\tkzDrawSegment(A,B)
\tkzLabelSegment[above,pos=.8](A,B){$a$}
\tkzLabelSegment[below,pos=.2](A,B){$4$}
\end{tikzpicture}
```

### 31.0.2. Example : blackboard




```
\tikzstyle{background rectangle}=[fill=black]
\begin{tikzpicture}[show background rectangle,scale=.4]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(1,0){I}
  \tkzDefPoint(10,0){A}
  \tkzDefPointWith[orthogonal normed,K=4](I,A)
   \tkzGetPoint{H}
  \tkzDefMidPoint(O,A) \tkzGetPoint{M}
  \tkzInterLC(I,H)(M,A)\tkzGetPoints{B}{C}
  \tkzDrawSegments[color=white,line width=1pt](I,H O,A)
  \tkzDrawPoints[color=white](O,I,A,B,M)
  \tkzMarkRightAngle[color=white,line width=1pt](A,I,B)
  \tkzDrawArc[color=white,line width=1pt,
            style=dashed](M,A)(O)
  \tkzLabelSegment[white,right=1ex,pos=.5](I,B){$\sqrt{a}$}
  \tkzLabelSegment[white,below=1ex,pos=.5](O,I){$1$}
  \tkzLabelSegment[pos=.6,white,below=1ex](I,A){$a$}
\end{tikzpicture}
```

### 31.0.3. Labels and option : swap

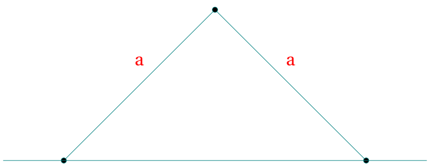



```
\begin{tikzpicture}[rotate=-60]
\tkzSetUpStyle[red,auto]{label style}
\tkzDefPoint(0,1){A}
\tkzDefPoint(2,4){C}
\tkzDefPointWith[orthogonal normed,K=7](C,A)
\tkzGetPoint{B}
\tkzDefSpcTriangle[orthic](A,B,C){N,O,P}
\tkzDefTriangleCenter[circum](A,B,C)
\tkzGetPoint{O}
\tkzDrawPolygon[green!60!black](A,B,C)
\tkzDrawLine[dashed,color=magenta](C,P)
\tkzLabelSegment(B,A){$c$}
\tkzLabelSegment[swap](B,C){$a$}
\tkzLabelSegment[swap](C,A){$b$}
\tkzMarkAngles[size=1,
     color=cyan,mark=|](C,B,A A,C,P)
\tkzMarkAngle[size=0.75,
     color=orange,mark=||](P,C,B)
\tkzMarkAngle[size=0.75,
      color=orange,mark=||](B,A,C)
\tkzMarkRightAngles[german](A,C,B B,P,C)
\tkzAutoLabelPoints[center = O,dist= .1](A,B,C)
 \tkzLabelPoint[below left](P){$P$}
 \end{tikzpicture}
```

`\tkzLabelSegments[⟨local options⟩](⟨pt1,pt2 pt3,pt4 ...⟩)`

The arguments are a two-point couple list. The styles of TikZ are available for plotting.

### 31.0.4. Labels for an isosceles triangle




```
\begin{tikzpicture}[scale=1]
 \tkzDefPoints{0/0/O,2/2/A,4/0/B,6/2/C}
 \tkzDrawSegments(O,A A,B)
 \tkzDrawPoints(O,A,B)
 \tkzDrawLine(O,B)
 \tkzLabelSegments[color=red,above=4pt](O,A A,B){$a$}
\end{tikzpicture}
```

## 32. Add labels on a straight line \tkzLabelLine

`\tkzLabelLine[⟨local options⟩](⟨pt1,pt2⟩){⟨label⟩}`

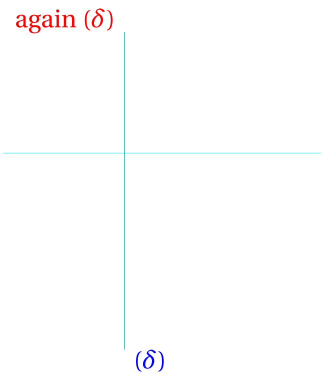
| arguments | default | definition |
|---|---|---|
| label | | `\tkzLabelLine(A,B){$\Delta$}` |

| options | default | definition |
|---|---|---|
| pos | .5 | `pos` is an option for TikZ, but essential in this case... |

As an option, and in addition to the `pos`, you can use all styles of TikZ, especially the placement with `above`, `right`, ...

### 32.0.1. Example with \tkzLabelLine

An important option is `pos`, it's the one that allows you to place the label along the right. The value of `pos` can be greater than 1 or negative.




```
\begin{tikzpicture}
   \tkzDefPoints{0/0/A,3/0/B,1/1/C}
   \tkzDefLine[perpendicular=through C,K=-1](A,B)
   \tkzGetPoint{c}
   \tkzDrawLines(A,B C,c)
   \tkzLabelLine[pos=1.25,blue,right](C,c){$(\delta)$}
   \tkzLabelLine[pos=-0.25,red,left](C,c){again $(\delta)$}
\end{tikzpicture}
```

## 32.1. Label at an angle : \tkzLabelAngle

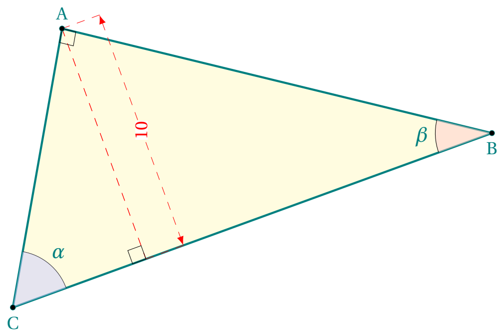
`\tkzLabelAngle[⟨local options⟩](⟨A,O,B⟩)`

There is only one option, dist (with or without unit), which can be replaced by the TikZ's pos option (without unit for the latter). By default, the value is in centimeters.

| options | default | definition |
|---|---|---|
| pos | 1 | or dist, controls the distance from the top to the label. |

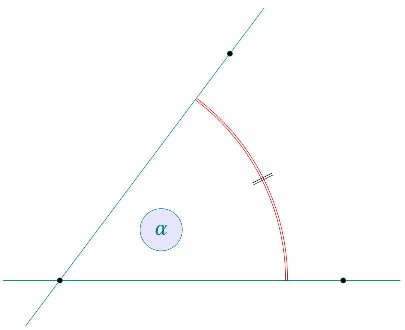
It is possible to move the label with all TikZ options : rotate, shift, below, etc.

#### 32.1.1. Example author js bibra stackexchange



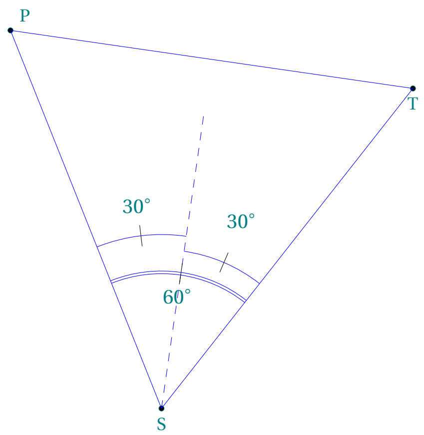

```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoint(0,0){C}
  \tkzDefPoint(20:9){B}
  \tkzDefPoint(80:5){A}
  \tkzDefPointsBy[projection=onto B--C](A){a}
  \tkzDrawPolygon[thick,fill=yellow!15](A,B,C)
  \tkzDrawSegment[dashed, red](A,a)
  \tkzDrawSegment[style=red, dashed,
  dim={$10$,15pt,midway,font=\scriptsize,
   rotate=90}](A,a)
  \tkzMarkAngle(B,C,A)
  \tkzMarkRightAngle(A,a,C)
  \tkzMarkRightAngle(C,A,B)
  \tkzFillAngle[fill=blue!20, opacity=0.5](B,C,A)
  \tkzFillAngle[fill=red!20, opacity=0.5](A,B,C)
  \tkzLabelAngle[pos=1.25](A,B,C){$\beta$}
  \tkzLabelAngle[pos=1.25](B,C,A){$\alpha$}
  \tkzMarkAngle(A,B,C)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(B,C)
  \tkzLabelPoints[above](A)
\end{tikzpicture}
```

#### 32.1.2. With pos




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/O,5/0/A,3/4/B}
  \tkzMarkAngle[size = 4,mark = ||,
      arc=ll,color = red](A,O,B)%
  \tkzDrawLines(O,A O,B)
  \tkzDrawPoints(O,A,B)
  \tkzLabelAngle[pos=2,draw,circle,
      fill=blue!10](A,O,B){$\alpha$}
\end{tikzpicture}
```

### 32.1.3. pos and \tkzLabelAngles




```
\begin{tikzpicture}[rotate=30]
  \tkzDefPoint(2,1){S}
  \tkzDefPoint(7,3){T}
  \tkzDefPointBy[rotation=center S angle 60](T)
  \tkzGetPoint{P}
  \tkzDefLine[bisector,normed](T,S,P)
  \tkzGetPoint{s}
  \tkzDrawPoints(S,T,P)
  \tkzDrawPolygon[color=blue](S,T,P)
  \tkzDrawLine[dashed,color=blue,add=0 and 3](S,s)
  \tkzLabelPoint[above right](P){$P$}
  \tkzLabelPoints(S,T)
  \tkzMarkAngle[size = 1.8,mark = |,arc=ll,
                  color = blue](T,S,P)
  \tkzMarkAngle[size = 2.1,mark = |,arc=l,
                  color = blue](T,S,s)
  \tkzMarkAngle[size = 2.3,mark = |,arc=l,
                  color = blue](s,S,P)
 \tkzLabelAngle[pos = 1.5](T,S,P){$60^{\circ}$}%
 \tkzLabelAngles[pos = 2.7](T,S,s s,S,P){%
                          $30^{\circ}$}%
\end{tikzpicture}
```

**\tkzLabelAngles[⟨local options⟩](⟨A,O,B⟩)(⟨A',O',B'⟩)etc.**

With common options, there is a macro for multiple angles.

It finally remains to be able to give a label to designate a circle and if several possibilities are offered, we will see here \tkzLabelCircle.

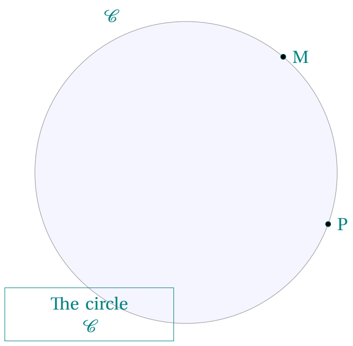
## 32.2. Giving a label to a circle

**\tkzLabelCircle[⟨tikz options⟩](⟨O,A⟩)(⟨angle⟩){⟨label⟩}**

| options | default | definition |
|---|---|---|
| tikz options | | circle O center through A |

*We can use the styles from TikZ. The label is created and therefore passed between braces.*

### 32.2.1. Example




```
\begin{tikzpicture}
 \tkzDefPoint(0,0){O} \tkzDefPoint(2,0){N}
 \tkzDefPointBy[rotation=center O angle 50](N)
     \tkzGetPoint{M}
 \tkzDefPointBy[rotation=center O angle -20](N)
      \tkzGetPoint{P}
 \tkzDefPointBy[rotation=center O angle 125](N)
      \tkzGetPoint{P'}
 \tkzLabelCircle[above=4pt](O,N)(120){$\mathcal{C}$}
 \tkzDrawCircle(O,M)
 \tkzFillCircle[color=blue!10,opacity=.4](O,M)
 \tkzLabelCircle[draw,
       text width=2cm,text centered,left=24pt](O,M)(-120)%
          {The circle\\ $\mathcal{C}$}
 \tkzDrawPoints(M,P)\tkzLabelPoints[right](M,P)
\end{tikzpicture}
```

## 33. Label for an arc

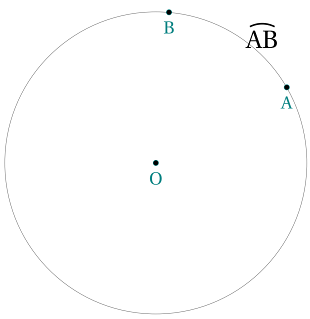
**\tkzLabelArc[⟨local options⟩](⟨pt1,pt2,pt3⟩){⟨label⟩}**

This macro allows you to place a label along an arc. The options are those of Ti*k*Z for example `pos`.

| argument | example | definition |
|---|---|---|
| label | `\tkzLabelArc(A,B){5}` | label text |
| (pt1,pt2,pt3) | (O,A,B) | label along the arc $\widearc{AB}$ |

| options | default | definition |
|---|---|---|
| pos | .5 | label's position |

### 33.0.1. Label on arc




```
\begin{tikzpicture}
\tkzDefPoint(0,0){O}
\pgfmathsetmacro\r{2}
\tkzDefPoint(30:\r){A}
\tkzDefPoint(85:\r){B}
\tkzDrawCircle(O,A)
\tkzDrawPoints(B,A,O)
\tkzLabelArc[right=2pt](O,A,B){$\widearc{AB}$}
\tkzLabelPoints(A,B,O)
\end{tikzpicture}
```

# Part VII.

# Complements

# 34. Using the compass

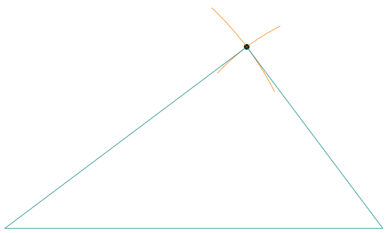
## 34.1. Main macro \tkzCompass

`\tkzCompass[⟨local options⟩](⟨A,B⟩)`

This macro allows you to leave a compass trace, i.e. an arc at a designated point. The center must be indicated. Several specific options will modify the appearance of the arc as well as TikZ options such as style, color, line thickness etc.
You can define the length of the arc with the option `length` or the option `delta`.

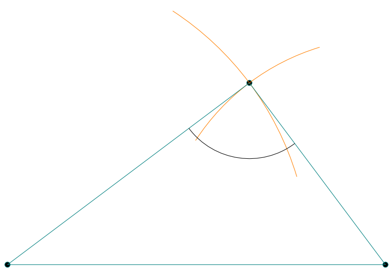
| options | default | definition |
|---|---|---|
| delta | 0 (deg) | Increases the angle of the arc symmetrically |
| length | 1 (cm) | Changes the length (in cm) |

### 34.1.1. Option length



```
\begin{tikzpicture}
  \tkzDefPoint(1,1){A}
  \tkzDefPoint(6,1){B}
  \tkzInterCC[R](A,4)(B,3)
  \tkzGetPoints{C}{D}
  \tkzDrawPoint(C)
  \tkzCompass[length=1.5](A,C)
  \tkzCompass(B,C)
  \tkzDrawSegments(A,B A,C B,C)
\end{tikzpicture}
```

### 34.1.2. Option delta



```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(5,0){B}
  \tkzInterCC[R](A,4)(B,3)
  \tkzGetPoints{C}{D}
  \tkzDrawPoints(A,B,C)
  \tkzCompass[delta=20](A,C)
  \tkzCompass[delta=20](B,C)
  \tkzDrawPolygon(A,B,C)
  \tkzMarkAngle(A,C,B)
\end{tikzpicture}
```

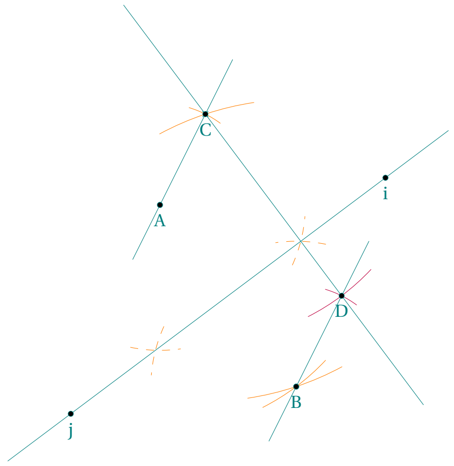
## 34.2. Multiple constructions \tkzCompasss

`\tkzCompasss[⟨local options⟩](⟨pt1,pt2 pt3,pt4,…⟩)`

Attention the arguments are lists of two points. This saves a few lines of code.

| options | default | definition |
|---|---|---|
| delta | 0 | Modifies the angle of the arc by increasing it symmetrically |
| length | 1 | Changes the length |

### 34.2.1. Use \tkzCompasss




```
\begin{tikzpicture}[scale=.6]
 \tkzDefPoint(2,2){A}  \tkzDefPoint(5,-2){B}
 \tkzDefPoint(3,4){C}  \tkzDrawPoints(A,B)
 \tkzDrawPoint[shape=cross out](C)
 \tkzCompasss[new](A,B A,C B,C C,B)
 \tkzShowLine[mediator,new,dashed,length = 2](A,B)
 \tkzShowLine[parallel = through C,
                   color=purple,length=2](A,B)
 \tkzDefLine[mediator](A,B)
  \tkzGetPoints{i}{j}
 \tkzDefLine[parallel=through C](A,B)
   \tkzGetPoint{D}
 \tkzDrawLines[add=.6 and .6](C,D A,C B,D)
 \tkzDrawLines(i,j) \tkzDrawPoints(A,B,C,i,j,D)
 \tkzLabelPoints(A,B,C,i,j,D)
\end{tikzpicture}
```

# 35. The Show

## 35.1. Show the constructions of some lines \tkzShowLine

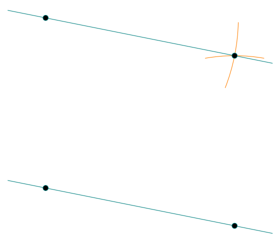
\tkzShowLine[⟨local options⟩](⟨pt1,pt2⟩) or (⟨pt1,pt2,pt3⟩)

These constructions concern mediatrices, perpendicular or parallel lines passing through a given point and bisectors. The arguments are therefore lists of two or three points. Several options allow the adjustment of the constructions. The idea of this macro comes from Yves Combe.

| options | default | definition |
|---|---|---|
| mediator | mediator | displays the constructions of a mediator |
| perpendicular | mediator | constructions for a perpendicular |
| orthogonal | mediator | idem |
| bisector | mediator | constructions for a bisector |
| K | 1 | circle within a triangle |
| length | 1 | in cm, length of a arc |
| ratio | .5 | arc length ratio |
| gap | 2 | placing the point of construction |
| size | 1 | radius of an arc (see bisector) |

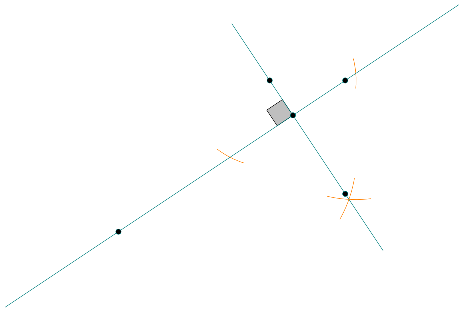
You have to add, of course, all the styles of Ti*k*Z for tracings…

### 35.1.1. Example of \tkzShowLine and parallel



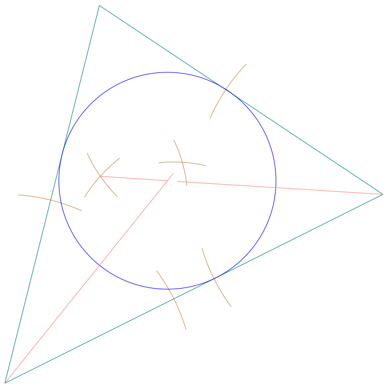
```
\begin{tikzpicture}
 \tkzDefPoints{-1.5/-0.25/A,1/-0.75/B,-1.5/2/C}
 \tkzDrawLine(A,B)
 \tkzDefLine[parallel=through C](A,B) \tkzGetPoint{c}
 \tkzShowLine[parallel=through C](A,B)
 \tkzDrawLine(C,c) \tkzDrawPoints(A,B,C,c)
\end{tikzpicture}
```

### 35.1.2. Example of \tkzShowLine and perpendicular



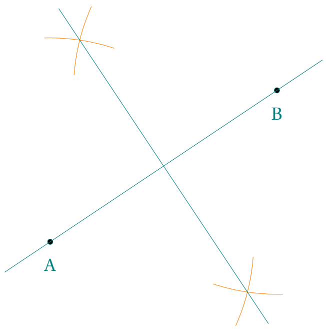
```
\begin{tikzpicture}
\tkzDefPoints{0/0/A, 3/2/B, 2/2/C}
\tkzDefLine[perpendicular=through C,K=-.5](A,B)
\tkzGetPoint{c}
\tkzShowLine[perpendicular=through C,K=-.5,gap=3](A,B)
\tkzDefPointBy[projection=onto A--B](c)
\tkzGetPoint{h}
\tkzMarkRightAngle[fill=lightgray](A,h,C)
\tkzDrawLines[add=.5 and .5](A,B C,c)
\tkzDrawPoints(A,B,C,h,c)
\end{tikzpicture}
```

### 35.1.3. Example of \tkzShowLine and bisector



```
\begin{tikzpicture}[scale=1.25]
 \tkzDefPoints{0/0/A, 4/2/B, 1/4/C}
 \tkzDrawPolygon(A,B,C)
 \tkzSetUpCompass[color=brown,line width=.1 pt]
 \tkzDefLine[bisector](B,A,C)  \tkzGetPoint{a}
 \tkzDefLine[bisector](C,B,A)  \tkzGetPoint{b}
 \tkzInterLL(A,a)(B,b) \tkzGetPoint{I}
 \tkzDefPointBy[projection = onto A--B](I)
   \tkzGetPoint{H}
 \tkzShowLine[bisector,size=2,gap=3,blue](B,A,C)
 \tkzShowLine[bisector,size=2,gap=3,blue](C,B,A)
 \tkzDrawCircle[color=blue,%
 line width=.2pt](I,H)
 \tkzDrawSegments[color=red!50](I,tkzPointResult)
 \tkzDrawLines[add=0 and -0.3,color=red!50](A,a B,b)
\end{tikzpicture}
```

### 35.1.4. Example of \tkzShowLine and mediator




```
\begin{tikzpicture}
\tkzDefPoint(2,2){A}
\tkzDefPoint(5,4){B}
\tkzDrawPoints(A,B)
\tkzShowLine[mediator,color=orange,length=1](A,B)
\tkzGetPoints{i}{j}
\tkzDrawLines[add=-0.1 and -0.1](i,j)
\tkzDrawLines(A,B)
\tkzLabelPoints[below =3pt](A,B)
\end{tikzpicture}
```

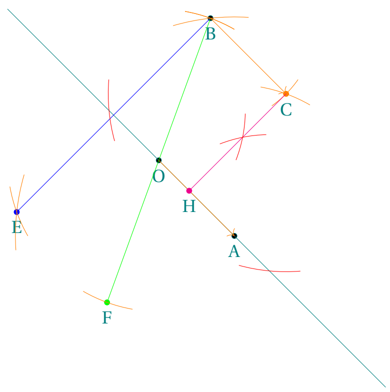
## 35.2. Constructions of certain transformations \tkzShowTransformation

`\tkzShowTransformation[⟨local options⟩](⟨pt1,pt2⟩) or (⟨pt1,pt2,pt3⟩)`

These constructions concern orthogonal symmetries, central symmetries, orthogonal projections and translations. Several options allow the adjustment of the constructions. The idea of this macro comes from Yves Combe.

| options | default | definition |
|---|---|---|
| reflection= over pt1--pt2 | reflection | constructions of orthogonal symmetry |
| symmetry=center pt | reflection | constructions of central symmetry |
| projection=onto pt1--pt2 | reflection | constructions of a projection |
| translation=from pt1 to pt2 | reflection | constructions of a translation |
| K | 1 | circle within a triangle |
| length | 1 | arc length |
| ratio | .5 | arc length ratio |
| gap | 2 | placing the point of construction |
| size | 1 | radius of an arc (see bisector) |

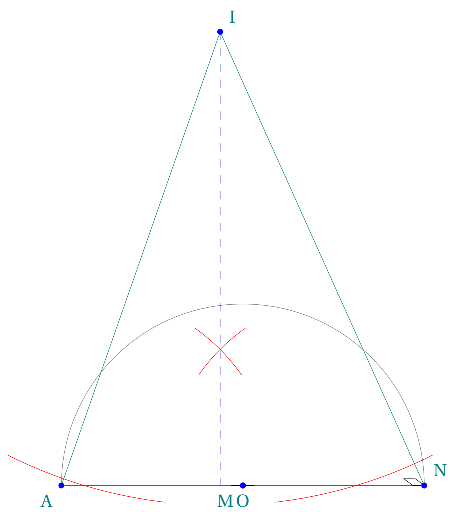
### 35.2.1. Example of the use of \tkzShowTransformation




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoint(0,0){O} \tkzDefPoint(2,-2){A}
  \tkzDefPoint(70:4){B} \tkzDrawPoints(A,O,B)
  \tkzLabelPoints(A,O,B)
  \tkzDrawLine[add= 2 and 2](O,A)
  \tkzDefPointBy[translation=from O to A](B)
  \tkzGetPoint{C}
  \tkzDrawPoint[color=orange](C)  \tkzLabelPoints(C)
  \tkzShowTransformation[translation=from O to A,%
            length=2](B)
  \tkzDrawSegments[->,color=orange](O,A B,C)
  \tkzDefPointBy[reflection=over O--A](B) \tkzGetPoint{E}
  \tkzDrawSegment[blue](B,E)
  \tkzDrawPoint[color=blue](E)\tkzLabelPoints(E)
  \tkzShowTransformation[reflection=over O--A,size=2](B)
  \tkzDefPointBy[symmetry=center O](B) \tkzGetPoint{F}
  \tkzDrawSegment[color=green](B,F)
  \tkzDrawPoint[color=green](F)\tkzLabelPoints(F)
  \tkzShowTransformation[symmetry=center O,%
                    length=2](B)
  \tkzDefPointBy[projection=onto O--A](C)
  \tkzGetPoint{H}
  \tkzDrawSegments[color=magenta](C,H)
  \tkzDrawPoint[color=magenta](H)\tkzLabelPoints(H)
  \tkzShowTransformation[projection=onto O--A,%
                       color=red,size=3,gap=-2](C)
\end{tikzpicture}
```

### 35.2.2. Another example of the use of \tkzShowTransformation

You'll find this figure again, but without the construction features.




```
\begin{tikzpicture}[scale=.6]
  \tkzDefPoints{0/0/A,8/0/B,3.5/10/I}
  \tkzDefMidPoint(A,B) \tkzGetPoint{O}
  \tkzDefPointBy[projection=onto A--B](I)
     \tkzGetPoint{J}
  \tkzInterLC(I,A)(O,A)  \tkzGetPoints{M}{M'}
  \tkzInterLC(I,B)(O,A)  \tkzGetPoints{N}{N'}
  \tkzDefMidPoint(A,B) \tkzGetPoint{M}
  \tkzDrawSemiCircle(M,B)
  \tkzDrawSegments(I,A I,B A,B B,M A,N)
  \tkzMarkRightAngles(A,M,B A,N,B)
  \tkzDrawSegment[style=dashed,color=blue](I,J)
  \tkzShowTransformation[projection=onto A--B,
                 color=red,size=3,gap=-3](I)
  \tkzDrawPoints[color=red](M,N)
  \tkzDrawPoints[color=blue](O,A,B,I,M)
  \tkzLabelPoints(O)
  \tkzLabelPoints[above right](N,I)
  \tkzLabelPoints[below left](M,A)
\end{tikzpicture}
```

## 36. Protractor

Based on an idea by Yves Combe, the following macro allows you to draw a protractor. The operating principle is even simpler. Just name a half-line (a ray). The protractor will be placed on the origin O, the direction of the half-line is given by A. The angle is measured in the direct direction of the trigonometric circle.

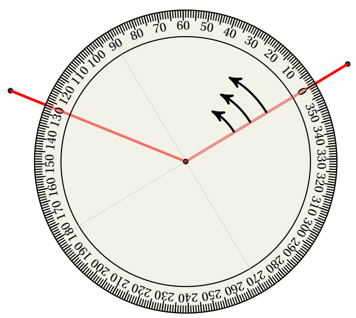
### 36.1. The macro \tkzProtractor

`\tkzProtractor[⟨local options⟩](⟨O,A⟩)`

| options | default | definition |
|---|---|---|
| lw | 0.4 pt | line thickness |
| scale | 1 | ratio: adjusts the size of the protractor |
| return | false | trigonometric circle indirect |

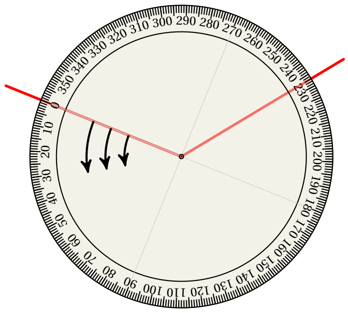
#### 36.1.1. The circular protractor

Measuring in the forward direction



```
\begin{tikzpicture}[scale=.5]
\tkzDefPoint(2,0){A}\tkzDefPoint(0,0){O}
\tkzDefShiftPoint[A](31:5){B}
\tkzDefShiftPoint[A](158:5){C}
\tkzDrawPoints(A,B,C)
\tkzDrawSegments[color = red,
    line width = 1pt](A,B A,C)
  \tkzProtractor[scale = 1](A,B)
\end{tikzpicture}
```

#### 36.1.2. The circular protractor, transparent and returned



```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoint(2,3){A}
  \tkzDefShiftPoint[A](31:5){B}
   \tkzDefShiftPoint[A](158:5){C}
  \tkzDrawSegments[color=red,line width=1pt](A,B A,C)
  \tkzProtractor[return](A,C)
\end{tikzpicture}
```

## 37. Miscellaneous tools and mathematical tools

### 37.1. Duplicate a segment

This involves constructing a segment on a given half-line of the same length as a given segment.

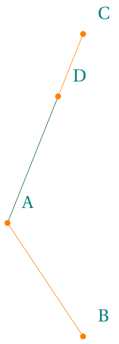
**\tkzDuplicateSegment(⟨pt1,pt2⟩)(⟨pt3,pt4⟩){⟨pt5⟩}**

This involves creating a segment on a given half-line of the same length as a given segment . It is in fact the definition of a point. **\tkzDuplicateSegment** is the new name of **\tkzDuplicateLen**.

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2)(pt3,pt4){pt5} | **\tkzDuplicateSegment**(A,B)(E,F){C} | AC=EF and $C \in [AB)$ |

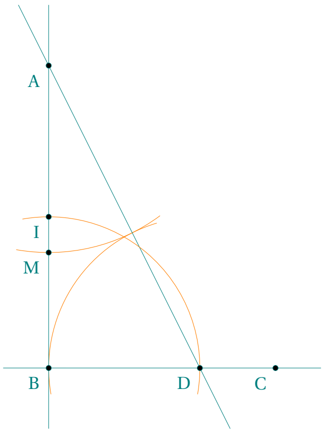
*The macro **\tkzDuplicateLength** is identical to this one.*

#### 37.1.1. Use of\tkzDuplicateSegment



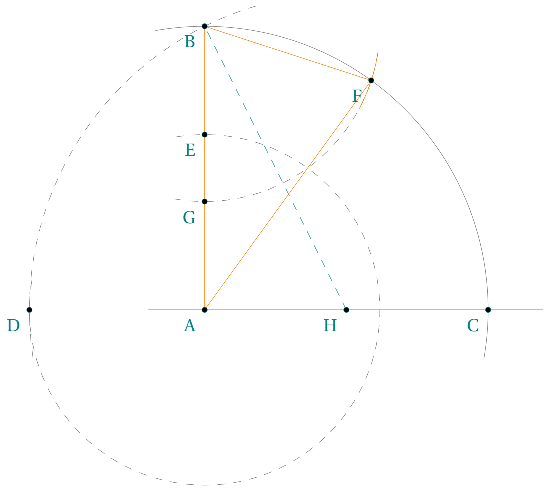

```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoints{0/0/A,2/-3/B,2/5/C}
 \tkzDuplicateSegment(A,B)(A,C)
 \tkzGetPoint{D}
 \tkzDrawSegments[new](A,B A,C)
 \tkzDrawSegment[teal](A,D)
 \tkzDrawPoints[new](A,B,C,D)
 \tkzLabelPoints[above right=3pt](A,B,C,D)
\end{tikzpicture}
```

### 37.1.2. Proportion of gold with \tkzDuplicateSegment




```
\begin{tikzpicture}[rotate=-90,scale=.4]
 \tkzDefPoints{0/0/A,10/0/B}
 \tkzDefMidPoint(A,B)
 \tkzGetPoint{I}
 \tkzDefPointWith[orthogonal,K=-.75](B,A)
 \tkzGetPoint{C}
 \tkzInterLC(B,C)(B,I)  \tkzGetSecondPoint{D}
 \tkzDuplicateSegment(B,D)(D,A) \tkzGetPoint{E}
 \tkzInterLC(A,B)(A,E)   \tkzGetPoints{N}{M}
 \tkzDrawArc[orange,delta=10](D,E)(B)
 \tkzDrawArc[orange,delta=10](A,M)(E)
 \tkzDrawLines(A,B B,C A,D)
 \tkzDrawArc[orange,delta=10](B,D)(I)
 \tkzDrawPoints(A,B,D,C,M,I)
 \tkzLabelPoints[below left](A,B,D,C,M,I)
\end{tikzpicture}
```

### 37.1.3. Golden triangle or sublime triangle




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/A,5/0/C,0/5/B}
  \tkzDefMidPoint(A,C)\tkzGetPoint{H}
  \tkzDuplicateSegment(H,B)(H,A)\tkzGetPoint{D}
  \tkzDuplicateSegment(A,D)(A,B)\tkzGetPoint{E}
  \tkzDuplicateSegment(A,D)(B,A)\tkzGetPoint{G}
  \tkzInterCC(A,C)(B,G)\tkzGetSecondPoint{F}
  \tkzDrawLine(A,C)
  \tkzDrawArc(A,C)(B)
  \begin{scope}[arc style/.style={color=gray,%
                                  style=dashed}]
    \tkzDrawArc(H,B)(D)
    \tkzDrawArc(A,D)(B)
    \tkzDrawArc(B,G)(F)
  \end{scope}
  \tkzDrawSegment[dashed](H,B)
  \tkzCompass(B,F)
  \tkzDrawPolygon[new](A,B,F)
  \tkzDrawPoints(A,...,H)
  \tkzLabelPoints[below left](A,...,H)
\end{tikzpicture}
```

## 37.2. Segment length \tkzCalcLength

There's an option in Ti*k*Z named `veclen`. This option is used to calculate AB if A and B are two points.
The only problem for me is that the version of Ti*k*Z is not accurate enough in some cases. My version uses the `xfp` package and is slower, but more accurate.

`\tkzCalcLength[⟨local options⟩](⟨pt1,pt2⟩)`

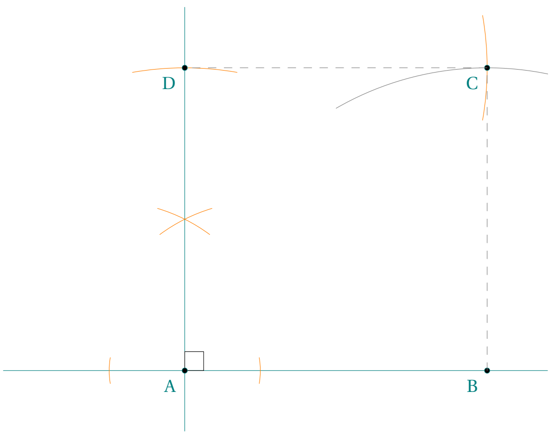
You can store the result with the macro `\tkzGetLength` for example `\tkzGetLength{dAB}` defines the macro `\dAB`.

| arguments | example | explanation |
|---|---|---|
| `(pt1,pt2){name of macro}` | `\tkzCalcLength(A,B)` | `\dAB gives AB in cm` |

Only one option

| options | default | example |
| --- | --- | --- |
| cm | true | \tkzCalcLength(A,B) After \tkzGetLength{dAB} \dAB gives AB in cm |

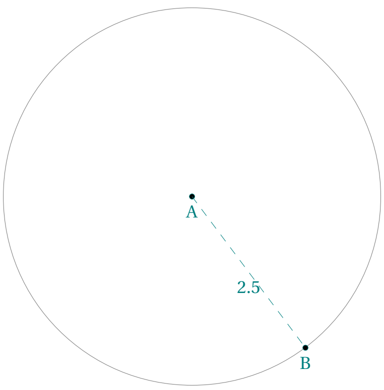
### 37.2.1. Compass square construction




```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){A} \tkzDefPoint(4,0){B}
  \tkzCalcLength(A,B)\tkzGetLength{dAB}
  \tkzDefLine[perpendicular=through A](A,B)
  \tkzGetPoint{D}
  \tkzDefPointWith[orthogonal,K=-1](B,A)
    \tkzGetPoint{F}
  \tkzGetPoint{C}
  \tkzDrawLine[add= .6 and .2](A,B)
  \tkzDrawLine(A,D)
  \tkzShowLine[orthogonal=through A,gap=2](A,B)
  \tkzMarkRightAngle(B,A,D)
  \tkzCompass(A,D D,C)
  \tkzDrawArc[R](B,\dAB)(80,110)
  \tkzDrawPoints(A,B,C,D)
  \tkzDrawSegments[color=gray,style=dashed](B,C C,D)
  \tkzLabelPoints[below left](A,B,C,D)
\end{tikzpicture}
```

### 37.2.2. Example

The macro `\tkzDefCircle[radius](A,B)` defines the radius that we retrieve with `\tkzGetLength`, this result is in `cm`.




```
\begin{tikzpicture}[scale=.5]
 \tkzDefPoint(0,0){A}
 \tkzDefPoint(3,-4){B}
 \tkzDefMidPoint(A,B) \tkzGetPoint{M}
 \tkzCalcLength(M,B)\tkzGetLength{rAB}
 \tkzDrawCircle(A,B)
 \tkzDrawPoints(A,B)
 \tkzLabelPoints(A,B)
 \tkzDrawSegment[dashed](A,B)
 \tkzLabelSegment(A,B){$\pgfmathprintnumber{\rAB}$}
\end{tikzpicture}
```

## 37.3. Transformation from pt to cm or cm to pt

Not sure if this is necessary and it is only a division by 28.45274 and a multiplication by the same number. The macros are:

`\tkzpttocm(⟨number⟩){⟨name of macro⟩}`

The result is stored in a macro.

| arguments | example | explanation |
| --- | --- | --- |
| (number){name of macro} | \tkzpttocm(120){len} | \len gives a number of tkznamecm |

You'll have to use `\len` along with `cm`.

## 37.4. Change of unit

`\tkzcmtopt(⟨number⟩){⟨name of macro⟩}`

The result is stored in a macro.

| arguments | example | explanation |
|---|---|---|
| (number){name of macro} | \tkzcmtopt(5){len} | \len length in pts |

*The result can be used with* `\len` *pt*

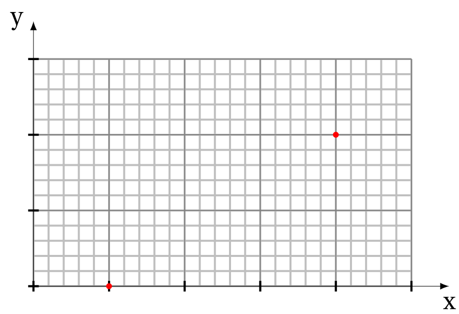
## 37.5. Get point coordinates

`\tkzGetPointCoord(⟨A⟩){⟨name of macro⟩}`

| arguments | example | explanation |
|---|---|---|
| (point){name of macro} | \tkzGetPointCoord(A){A} | \Ax and \Ay give coordinates for A |

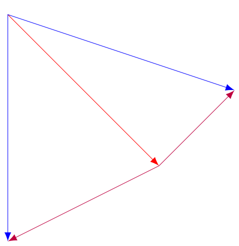
*Stores in two macros the coordinates of a point. If the name of the macro is* `p`*, then* `\px` *and* `\py` *give the coordinates of the chosen point with the cm as unit.*

### 37.5.1. Coordinate transfer with \tkzGetPointCoord




```
\begin{tikzpicture}
 \tkzInit[xmax=5,ymax=3]
 \tkzGrid[sub,orange]
 \tkzDrawX \tkzDrawY
 \tkzDefPoint(1,0){A}
 \tkzDefPoint(4,2){B}
 \tkzGetPointCoord(A){a}
 \tkzGetPointCoord(B){b}
 \tkzDefPoint(\ax,\ay){C}
 \tkzDefPoint(\bx,\by){D}
 \tkzDrawPoints[color=red](C,D)
\end{tikzpicture}
```

### 37.5.2. Sum of vectors with \tkzGetPointCoord



```
\begin{tikzpicture}[>=latex]
  \tkzDefPoint(1,4){a}
  \tkzDefPoint(3,2){b}
  \tkzDefPoint(1,1){c}
  \tkzDrawSegment[->,red](a,b)
  \tkzGetPointCoord(c){c}
  \draw[color=blue,->](a) -- ([shift=(b)]\cx,\cy) ;
  \draw[color=purple,->](b) -- ([shift=(b)]\cx,\cy) ;
  \tkzDrawSegment[->,blue](a,c)
  \tkzDrawSegment[->,purple](b,c)
\end{tikzpicture}
```

## 37.6. Swap labels of points

`\tkzSwapPoints(⟨pt1,pt2⟩)`

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2) | `\tkzSwapPoints(A,B)` | now A has the coordinates of B |

*The points have exchanged their coordinates.*

### 37.6.1. Use of `\tkzSwapPoints`


```
\begin{tikzpicture}
  \tkzDefPoints{0/0/O,5/-1/A,2/2/B}
   \tkzSwapPoints(A,B)
   \tkzDrawPoints(O,A,B)
   \tkzLabelPoints(O,A,B)
\end{tikzpicture}
```

## 37.7. Dot Product

In Euclidean geometry, the dot product of the Cartesian coordinates of two vectors is widely used.

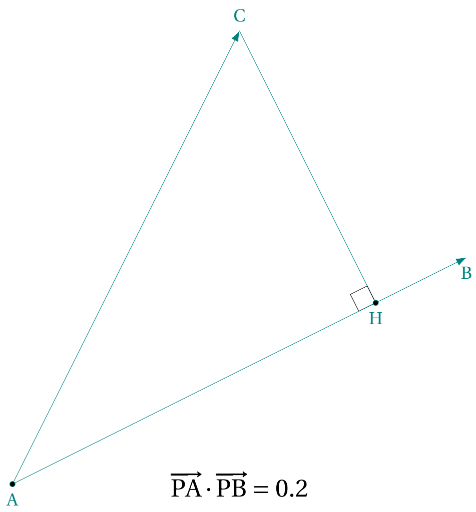
`\tkzDotProduct(⟨pt1,pt2,pt3⟩)`

The dot product of two vectors $\vec{u}=[a,b]$ and $\vec{v}=[a',b']$ is defined as: $\vec{u}\cdot\vec{v}=aa'+bb'$
$\vec{u}=\overrightarrow{pt1pt2}$ $\vec{v}=\overrightarrow{pt1pt3}$

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2,pt3) | `\tkzDotProduct(A,B,C)` | the result is $\overrightarrow{AB}\cdot\overrightarrow{AC}$ |

*The result is a number that can be retrieved with* `\tkzGetResult`.

### 37.7.1. Simple example

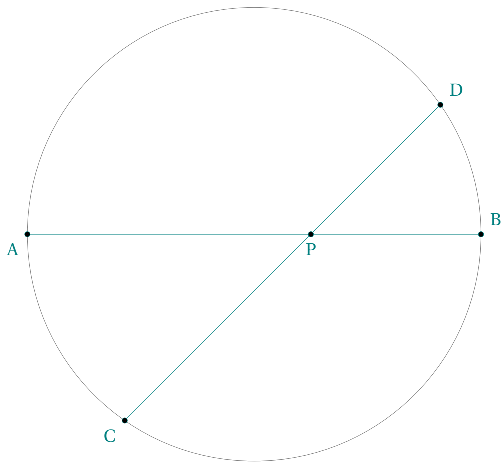



$\overrightarrow{PA} \cdot \overrightarrow{PB} = 0.2$

$PA \times PH = 0.2$

```
\begin{tikzpicture}
  \tkzDefPoints{-2/-3/A,4/0/B,1/3/C}
  \tkzDefPointBy[projection= onto A--B](C)
  \tkzGetPoint{H}
  \tkzDrawSegment(C,H)
  \tkzMarkRightAngle(C,H,A)
  \tkzDrawSegments[vector style](A,B A,C)
  \tkzDrawPoints(A,H) \tkzLabelPoints(A,B,H)
  \tkzLabelPoints[above](C)
  \tkzDotProduct(A,B,C) \tkzGetResult{pabc}
 % \pgfmathparse{round(10*\pabc)/10}
  \let\pabc\pgfmathresult
  \node at (1,-3) {$\overrightarrow{PA}\cdot \overrightarrow{PB}=\pa
  \tkzDotProduct(A,H,B) \tkzGetResult{phab}
 % \pgfmathparse{round(10*\phab)/10}
  \let\phab\pgfmathresult
  \node at (1,-4) {$PA \times PH = \phab $};
\end{tikzpicture}
```

### 37.7.2. Cocyclic points




$\overrightarrow{PA} \cdot \overrightarrow{PB} = \overrightarrow{PC} \cdot \overrightarrow{PD}$

$\overrightarrow{PA} \cdot \overrightarrow{PB} = -15.0$

$\overrightarrow{PC} \cdot \overrightarrow{PD} = -15.0$

```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{1/2/O,5/2/B,2/2/P,3/3/Q}
  \tkzInterLC[common=B](O,B)(O,B) \tkzGetFirstPoint{A}
  \tkzInterLC[common=B](P,Q)(O,B) \tkzGetPoints{C}{D}
  \tkzDrawCircle(O,B)
  \tkzDrawSegments(A,B C,D)
  \tkzDrawPoints(A,B,C,D,P)
  \tkzLabelPoints(P)
  \tkzLabelPoints[below left](A,C)
  \tkzLabelPoints[above right](B,D)
  \tkzDotProduct(P,A,B) \tkzGetResult{pab}
  \pgfmathparse{round(10*\pab)/10}
  \let\pab\pgfmathresult
  \tkzDotProduct(P,C,D) \tkzGetResult{pcd}
  \pgfmathparse{round(10*\pcd)/10}
  \let\pcd\pgfmathresult
  \node at (1,-3) {%
  $\overrightarrow{PA}\cdot \overrightarrow{PB} =
   \overrightarrow{PC}\cdot \overrightarrow{PD}$};
  \node at (1,-4)%
  {$\overrightarrow{PA}\cdot \overrightarrow{PB}=\pab$};
 \node at (1,-5){%
 $\overrightarrow{PC}\cdot \overrightarrow{PD} =\pcd$};
\end{tikzpicture}
```

## 37.8. Power of a point with respect to a circle

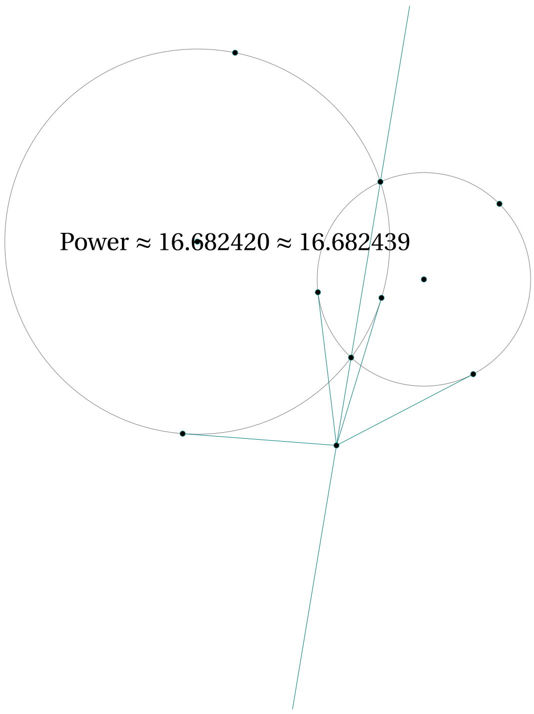
`\tkzPowerCircle(⟨pt1⟩)(⟨pt2,pt3⟩)`

| arguments | example | explanation |
|---|---|---|
| (pt1)(pt2,pt3) | \tkzPowerCircle(A)(O,M) | power of A with respect to the circle (O,A) |

*The result is a number that represents the power of a point with respect to a circle.*

### 37.8.1. Power from the radical axis

In this example, the radical axis (EF) has been drawn. A point H has been chosen on (EF) and the power of the point H with respect to the circle of center A has been calculated as well as $PS^2$. You can check that the power of H with respect to the circle of center C as well as $HS'^2, HT^2, HT'^2$ give the same result.




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{-1/0/A,0/5/B,5/-1/C,7/1/D}
  \tkzDrawCircles(A,B C,D)
  \tkzDefRadicalAxis(A,B)(C,D) \tkzGetPoints{E}{F}
  \tkzDrawLine[add=1 and 2](E,F)
  \tkzDefPointOnLine[pos=1.5](E,F)
  \tkzGetPoint{H}
  \tkzDefLine[tangent from = H](A,B)
  \tkzGetPoints{T}{T'}
  \tkzDefLine[tangent from = H](C,D)
  \tkzGetPoints{S}{S'}
  \tkzDrawSegments(H,T H,T' H,S H,S')
  \tkzDrawPoints(A,B,C,D,E,F,H,T,T',S,S')
  \tkzPowerCircle(H)(A,B) \tkzGetResult{pw}
  \tkzDotProduct(H,S,S) \tkzGetResult{phtt}
  \node {Power $\approx \pw \approx \phtt$};
\end{tikzpicture}
```

## 37.9. Radical axis

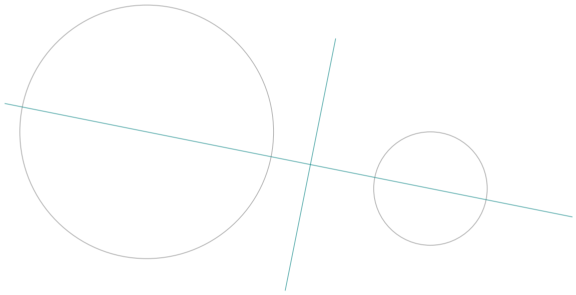
In geometry, the radical axis of two non-concentric circles is the set of points whose power with respect to the circles are equal. Here `\tkzDefRadicalAxis(A,B)(C,D)` gives the radical axis of the two circles $\mathscr{C}(A,B)$ and $\mathscr{C}(C,D)$.

`\tkzDefRadicalAxis(⟨pt1,pt2⟩)(⟨pt3,pt4⟩)`

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2)(pt3,pt4) | \tkzDefRadicalAxis(A,B)(C,D) | Two circles with centers A and C |

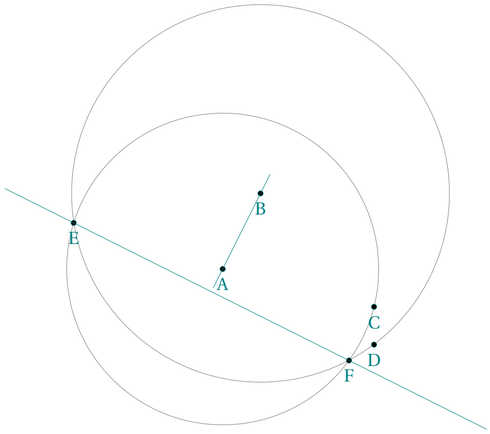
*The result is two points of the radical axis.*

### 37.9.1. Two circles disjointed



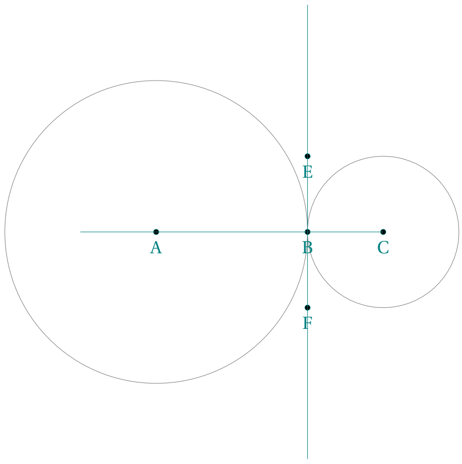
```
\begin{tikzpicture}[scale=.75]
    \tkzDefPoints{-1/0/A,0/2/B,4/-1/C,4/0/D}
    \tkzDrawCircles(A,B C,D)
    \tkzDefRadicalAxis(A,B)(C,D)
     \tkzGetPoints{E}{F}
    \tkzDrawLine[add=1 and 2](E,F)
    \tkzDrawLine[add=.5 and .5](A,C)
\end{tikzpicture}
```

### 37.10. Two intersecting circles



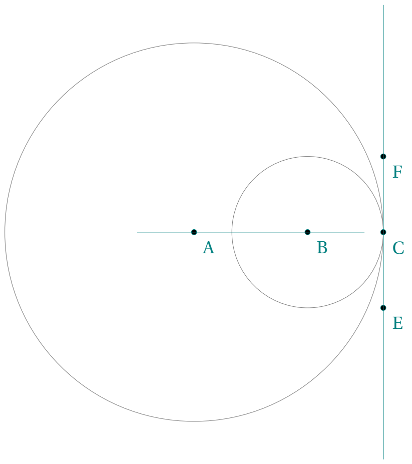

```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{-1/0/A,0/2/B,3/-1/C,3/-2/D}
  \tkzDrawCircles(A,C B,D)
  \tkzDefRadicalAxis(A,C)(B,D)
  \tkzGetPoints{E}{F}
  \tkzDrawPoints(A,B,C,D,E,F)
    \tkzLabelPoints(A,B,C,D,E,F)
  \tkzDrawLine[add=.25 and .5](E,F)
  \tkzDrawLine[add=.25 and .25](A,B)
\end{tikzpicture}
```

### 37.11. Two externally tangent circles



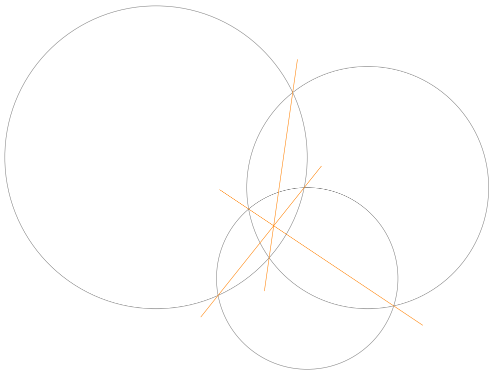

```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{0/0/A,4/0/B,6/0/C}
  \tkzDrawCircles(A,B C,B)
  \tkzDefRadicalAxis(A,B)(C,B)
  \tkzGetPoints{E}{F}
  \tkzDrawPoints(A,B,C,E,F)
    \tkzLabelPoints(A,B,C,E,F)
  \tkzDrawLine[add=1 and 1](E,F)
  \tkzDrawLine[add=.5 and .5](A,B)
\end{tikzpicture}
```

## 37.12. Two circles tangent internally




```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoints{0/0/A,3/0/B,5/0/C}
  \tkzDrawCircles(A,C B,C)
  \tkzDefRadicalAxis(A,C)(B,C)
  \tkzGetPoints{E}{F}
  \tkzDrawPoints(A,B,C,E,F)
  \tkzLabelPoints[below right](A,B,C,E,F)
  \tkzDrawLine[add=1 and 1](E,F)
  \tkzDrawLine[add=.5 and .5](A,B)
\end{tikzpicture}
```

### 37.12.1. Three circles



```
\begin{tikzpicture}[scale=.4]
  \tkzDefPoints{0/0/A,5/0/a,7/-1/B,3/-1/b,5/-4/C,2/-
4/c}
  \tkzDrawCircles(A,a B,b C,c)
  \tkzDefRadicalAxis(A,a)(B,b) \tkzGetPoints{i}{j}
  \tkzDefRadicalAxis(A,a)(C,c) \tkzGetPoints{k}{l}
  \tkzDefRadicalAxis(C,c)(B,b) \tkzGetPoints{m}{n}
  \tkzDrawLines[new](i,j k,l m,n)
\end{tikzpicture}
```

## 37.13. \tkzIsLinear, \tkzIsOrtho

**\tkzIsLinear(⟨pt1,pt2,pt3⟩)**

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2,pt3) | **\tkzIsLinear**(A,B,C) | A,B,C aligned ? |

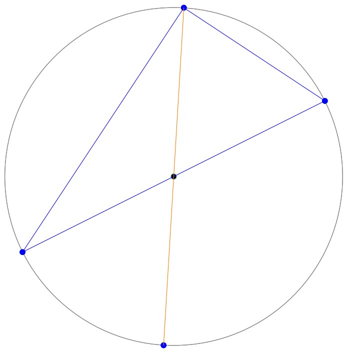
**\tkzIsLinear** *allows to test the alignment of the three points* pt1,pt2,pt3.

**\tkzIsOrtho(⟨pt1,pt2,pt3⟩)**

| arguments | example | explanation |
|---|---|---|
| (pt1,pt2,pt3) | **\tkzIsOrtho**(A,B,C) | (AB) ⊥ (AC) ? |

**\tkzIsOrtho** *allows to test the orthogonality of lines* (pt1pt2) *and* (pt1pt3).

#### 37.13.1. Use of \tkzIsOrtho and \tkzIsLinear



```
\begin{tikzpicture}
\tkzDefPoints{1/-2/A,5/0/B}
\tkzDefCircle[diameter](A,B) \tkzGetPoint{O}
\tkzDrawCircle(O,A)
\tkzDefPointBy[rotation= center O angle 60](B)
\tkzGetPoint{C}
\tkzDefPointBy[rotation= center O angle 60](A)
\tkzGetPoint{D}
\tkzDrawCircle(O,A)
\tkzDrawPoints(A,B,C,D,O)
\tkzIsOrtho(C,A,B)
\iftkzOrtho
  \tkzDrawPolygon[blue](A,B,C)
\tkzDrawPoints[blue](A,B,C,D)
\else
\tkzDrawPoints[red](A,B,C,D)
\fi
 \tkzIsLinear(O,C,D)
  \iftkzLinear
  \tkzDrawSegment[orange](C,D)
  \fi
\end{tikzpicture}
```

# Part VIII.

# Working with style

## 38. Predefined styles

The way to proceed will depend on your use of the package. A method that seems to me to be correct is to use as much as possible predefined styles in order to separate the content from the form. This method will be the right one if you plan to create a document (like this documentation) with many figures. We will see how to define a global style for a document. We will see how to use a style locally.
The file **tkz-euclide.cfg** contains the predefined styles of the main objects. Among these the most important are points, lines, segments, circles, arcs and compass traces. If you always use the same styles and if you create many figures then it is interesting to create your own styles . To do this you need to know what features you can modify. It will be necessary to know some notions of Ti*k*Z.
The predefined styles are global styles. They exist before the creation of the figures. It is better to avoid changing them between two figures. On the other hand these styles can be modified in a figure temporarily. There the styles are defined locally and do not influence the other figures.
For the document you are reading here is how I defined the different styles.

```
\tkzSetUpColors[background=white,text=black]
\tkzSetUpPoint[size=2,color=teal]
\tkzSetUpLine[line width=.4pt,color=teal]
\tkzSetUpCompass[color=orange, line width=.4pt,delta=10]
\tkzSetUpArc[color=gray,line width=.4pt]
\tkzSetUpStyle[orange]{new}
```

The macro `\tkzSetUpColors` allows you to set the background color as well as the text color. If you don't use it, the colors of your document will be used as well as the fonts. Let's see how to define the styles of the main objects.

## 39. Points style

This is how the points are defined :

```
\tikzset{point style/.style = {%
       draw         = \tkz@euc@pointcolor,
       inner sep    = 0pt,
       shape        = \tkz@euc@pointshape,
       minimum size = \tkz@euc@pointsize,
       fill         = \tkz@euc@pointcolor}}
```

It is of course possible to use `\tikzset` but you can use a macro provided by the package. You can use the macro `\tkzSetUpPoint` globally or locally,
Let's look at this possibility.

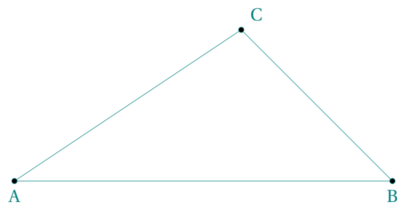
### 39.1. Use of \tkzSetUpPoint

`\tkzSetUpPoint[⟨local options⟩]`

| options | default | definition |
|---|---|---|
| color | black | point color |
| size | 3 | point size |
| fill | black!50 | inside point color |
| shape | circle | point shape circle, cross or cross out |

#### 39.1.1. Global style or local style

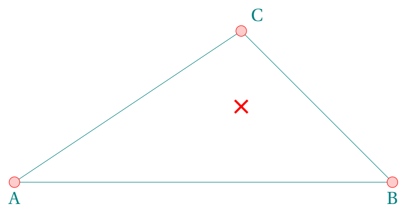
First of all here is a figure created with the styles of my documentation, then the style of the points is modified within the environment **tikzspicture**.
You can use the macro `\tkzSetUpPoint` globally or locally, If you place this macro in your preamble or before your first figure then the point style will be valid for all figures in your document. It will be possible to use another style locally by using this command within an environment **tikzpicture**.
Let's look at this possibility.




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,5/0/B,3/2/C,3/1/D}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPoints(A,B,C)
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[above right](C)
\end{tikzpicture}
```

#### 39.1.2. Local style

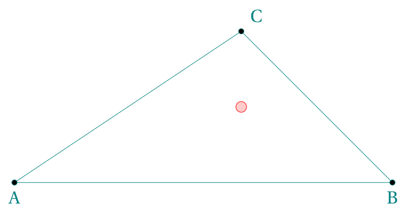
The style of the points is modified locally in the second figure




```
\begin{tikzpicture}
  \tkzSetUpPoint[size=4,color=red,fill=red!20]
  \tkzDefPoints{0/0/A,5/0/B,3/2/C,3/1/D}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPoints(A,B,C)
  \tkzDrawPoint[shape=cross out,thick](D)
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[above right](C)
\end{tikzpicture}
```

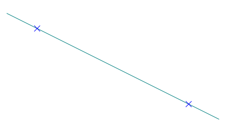
#### 39.1.3. Style and scope

The points get back the initial style. Point D has a new style limited by the environment **scope**. It is also possible to use `{...}` orThe points get back the initial style. Point D has a new style limited by the environment **scope**. It is also possible to use `{...}` or `\begingoup ... \endgroup`.



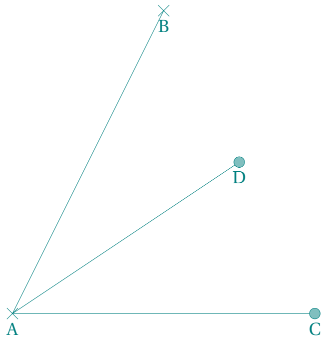

```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,5/0/B,3/2/C,3/1/D}
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPoints(A,B,C)
  \begin{scope}
    \tkzSetUpPoint[size=4,color=red,fill=red!20]
    \tkzDrawPoint(D)
  \end{scope}
  \tkzLabelPoints(A,B)
  \tkzLabelPoints[above right](C)
\end{tikzpicture}
```

#### 39.1.4. Simple example with \tkzSetUpPoint



```
\begin{tikzpicture}
  \tkzSetUpPoint[shape = cross out,color=blue]
  \tkzDefPoint(2,1){A}
  \tkzDefPoint(4,0){B}
  \tkzDrawLine(A,B)
  \tkzDrawPoints(A,B)
\end{tikzpicture}
```

#### 39.1.5. Use of \tkzSetUpPoint inside a group




```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,2/4/B,4/0/C,3/2/D}
  \tkzDrawSegments(A,B A,C A,D)
  {\tkzSetUpPoint[shape=cross out,
            fill= teal!50,
            size=4,color=teal]
  \tkzDrawPoints(A,B)}
  \tkzSetUpPoint[fill= teal!50,size=4,
              color=teal]
   \tkzDrawPoints(C,D)
  \tkzLabelPoints(A,B,C,D)
\end{tikzpicture}
```

## 40. Lines style

You have several possibilities to change the style of a line. You can modify the style of a line with `\tkzSetUpLine` or directly modify the style of the lines with `\tikzset{line style/.style = ... }`
Reminder about **`line width`**: There are a number of predefined styles that provide more "natural" ways of setting the line width. You can also redefine these styles.

| predefined style | value of **`line width`** |
|---|---|
| ultra thin | 0.1 pt |
| very thin | 0.2 pt |
| thin | 0.4 pt |
| semithick | 0.6 pt |
| thick | 0.8 pt |
| very thick | 1.2 pt |
| ultra thick | 1.6 pt |

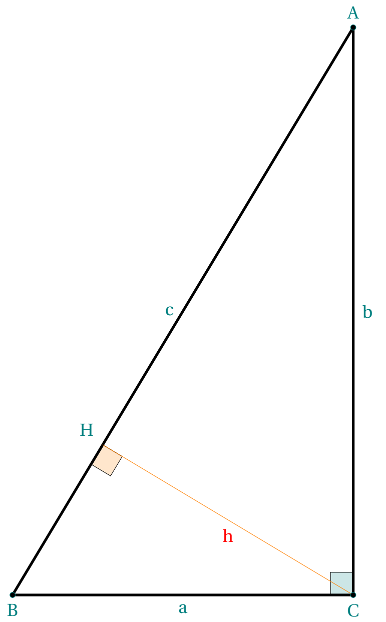
### 40.1. Use of \tkzSetUpLine

It is a macro that allows you to define the style of all the lines.

`\tkzSetUpLine[⟨local options⟩]`

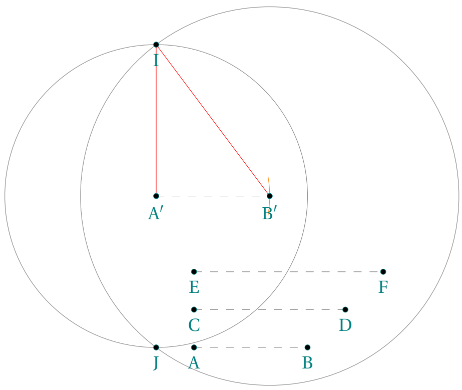
| options | default | definition |
|---|---|---|
| color | black | colour of the construction lines |
| line width | 0.4pt | thickness of the construction lines |
| style | solid | style of construction lines |
| add | .2 and .2 | changing the length of a line segment |

#### 40.1.1. Change line width



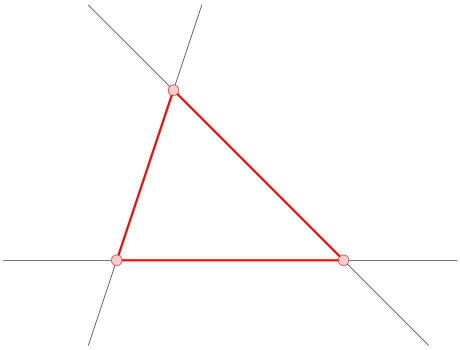

```
\begin{tikzpicture}[scale=.75]
\tkzSetUpLine[line width=1pt]
\begin{scope}[rotate=-90]
    \tkzDefPoints{0/6/A,10/0/B,10/6/C}
    \tkzDefPointBy[projection = onto B--A](C)
    \tkzGetPoint{H}
    \tkzMarkRightAngle[size=.4,
                       fill=teal!20](B,C,A)
    \tkzMarkRightAngle[size=.4,
                       fill=orange!20](B,H,C)
    \tkzDrawPolygon(A,B,C)
    \tkzDrawSegment[new](C,H)
\end{scope}
 \tkzLabelSegment[below](C,B){$a$}
 \tkzLabelSegment[right](A,C){$b$}
 \tkzLabelSegment[left](A,B){$c$}
 \tkzLabelSegment[color=red](C,H){$h$}
 \tkzDrawPoints(A,B,C)
 \tkzLabelPoints[above left](H)
 \tkzLabelPoints(B,C)
 \tkzLabelPoints[above](A)
\end{tikzpicture}
```

#### 40.1.2. Change style of line




```
\begin{tikzpicture}[scale=.5]
\tikzset{line style/.style = {color = gray,
                              style=dashed}}
\tkzDefPoints{1/0/A,4/0/B,1/1/C,5/1/D}
\tkzDefPoints{1/2/E,6/2/F,0/4/A',3/4/B'}
\tkzCalcLength(C,D)
\tkzGetLength{rCD}
\tkzCalcLength(E,F)
\tkzGetLength{rEF}
\tkzInterCC[R](A',\rCD)(B',\rEF)
\tkzGetPoints{I}{J}
\tkzDrawLine(A',B')
\tkzCompass(A',B')
\tkzDrawSegments(A,B C,D E,F)
\tkzDefCircle[R](A',\rCD) \tkzGetPoint{a'}
\tkzDefCircle[R](B',\rEF)\tkzGetPoint{b'}
\tkzDrawCircles(A',a' B',b')
\begin{scope}
  \tkzSetUpLine[color=red]
  \tkzDrawSegments(A',I B',I)
\end{scope}
\tkzDrawPoints(A,B,C,D,E,F,A',B',I,J)
\tkzLabelPoints(A,B,C,D,E,F,A',B',I,J)
\end{tikzpicture}
```

#### 40.1.3. Example 3: extend lines



```
\begin{tikzpicture}[scale=.75]
\tkzSetUpLine[add=.5 and .5]
\tkzDefPoints{0/0/A,4/0/B,1/3/C}
\tkzDrawLines(A,B B,C A,C)
\tkzDrawPolygon[red,thick](A,B,C)
\tkzSetUpPoint[size=4,circle,color=red,fill=red!20]
\tkzDrawPoints(A,B,C)
\end{tikzpicture}
```

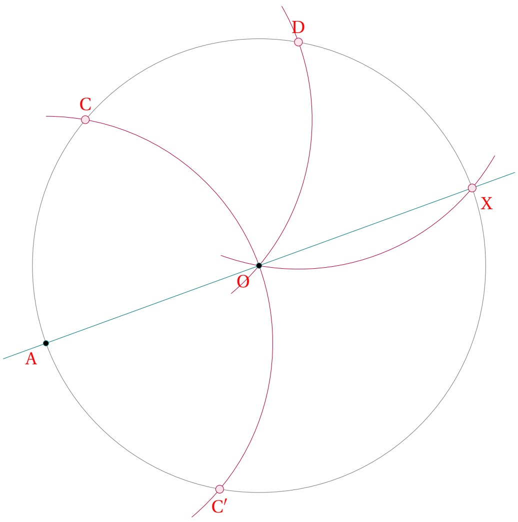
# 41. Arc style

## 41.1. The macro \tkzSetUpArc

\tkzSetUpArc[⟨local options⟩]

| options | default | definition |
|---|---|---|
| color | black | colour of the lines |
| line width | 0.4pt | thickness of the lines |
| style | solid | style of construction lines |

### 41.1.1. Use of \tkzSetUpArc




```
\begin{tikzpicture}
\def\r{3} \def\angle{200}
\tkzSetUpArc[delta=10,color=purple,line width=.2pt]
\tkzSetUpLabel[font=\scriptsize,red]
\tkzDefPoint(0,0){O}
\tkzDefPoint(\angle:\r){A}
\tkzInterCC(O,A)(A,O) \tkzGetPoints{C'}{C}
\tkzInterCC(O,A)(C,O) \tkzGetPoints{D'}{D}
\tkzInterCC(O,A)(D,O) \tkzGetPoints{X'}{X}
\tkzDrawCircle(O,A)
\tkzDrawArc(A,C')(C)
\tkzDrawArc(C,O)(D)
\tkzDrawArc(D,O)(X)
\tkzDrawLine[add=.1 and .1](A,X)
\tkzDrawPoints(O,A)
\tkzSetUpPoint[size=3,color=purple,fill=purple!10]
\tkzDrawPoints(C,C',D,X)
\tkzLabelPoints[below left](O,A)
\tkzLabelPoints[below](C')
\tkzLabelPoints[below right](X)
\tkzLabelPoints[above](C,D)
\end{tikzpicture}
```

## 42. Compass style, configuration macro \tkzSetUpCompass

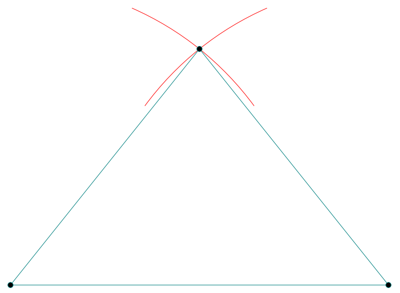
The following macro will help to understand the construction of a figure by showing the compass traces necessary to obtain certain points.

### 42.1. The macro \tkzSetUpCompass

`\tkzSetUpCompass[⟨local options⟩]`

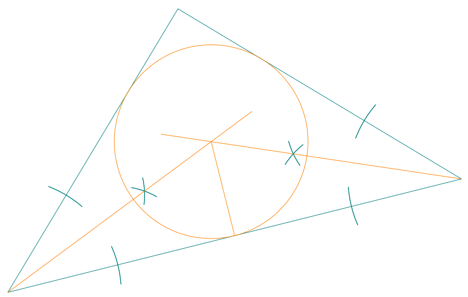
| options | default | definition |
|---|---|---|
| color | black | colour of the construction lines |
| line width | 0.4pt | thickness of the construction lines |
| style | solid | style of lines : solid, dashed,dotted,... |
| delta | 0 | changes the length of the arc |

#### 42.1.1. Use of \tkzSetUpCompass



```
\begin{tikzpicture}
  \tkzSetUpCompass[color=red,delta=15]
  \tkzDefPoint(1,1){A}
  \tkzDefPoint(6,1){B}
  \tkzInterCC[R](A,4)(B,4) \tkzGetPoints{C}{D}
  \tkzCompass(A,C)
  \tkzCompass(B,C)
  \tkzDrawPolygon(A,B,C)
  \tkzDrawPoints(A,B,C)
\end{tikzpicture}
```

#### 42.1.2. Use of \tkzSetUpCompass with \tkzShowLine



```
\begin{tikzpicture}[scale=.75]
\tkzSetUpStyle[bisector,size=2,gap=3]{showbi}
\tkzSetUpCompass[color=teal,line width=.3 pt]
\tkzDefPoints{0/1/A, 8/3/B, 3/6/C}
\tkzDrawPolygon(A,B,C)
\tkzDefLine[bisector](B,A,C) \tkzGetPoint{a}
\tkzDefLine[bisector](C,B,A) \tkzGetPoint{b}
\tkzShowLine[showbi](B,A,C)
\tkzShowLine[showbi](C,B,A)
\tkzInterLL(A,a)(B,b) \tkzGetPoint{I}
\tkzDefPointBy[projection= onto A--B](I)
\tkzGetPoint{H}
\tkzDrawCircle[new](I,H)
\tkzDrawSegments[new](I,H)
\tkzDrawLines[add=0 and .2,new](A,I B,I)
\end{tikzpicture}
```

## 43. Label style

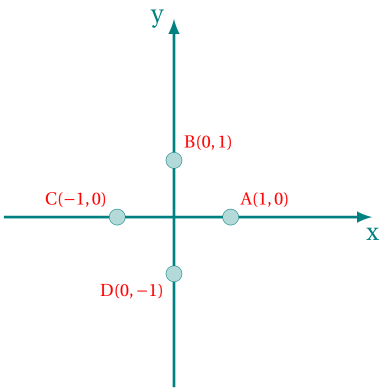
### 43.1. The macro \tkzSetUpLabel

The macro `\tkzSetUpLabel` is used to define the style of the point labels.

`\tkzSetUpStyle[⟨local options⟩]`

The options are the same as those of TikZ

#### 43.1.1. Use of \tkzSetUpLabel




```
\begin{tikzpicture}[scale=.75]
  \tkzSetUpLabel[font=\scriptsize,red]
  \tkzSetUpStyle[line width=1pt,teal]{XY}
  \tkzInit[xmin=-3,xmax=3,ymin=-3,ymax=3]
  \tkzDrawX[noticks,XY]
  \tkzDrawY[noticks,XY]
  \tkzDefPoints{1/0/A,0/1/B,-1/0/C,0/-1/D}
  \tkzDrawPoints[teal,fill=teal!30,size=6](A,...,D)
  \tkzLabelPoint[above right](A){$A(1,0)$}
  \tkzLabelPoint[above right](B){$B(0,1)$}
  \tkzLabelPoint[above left](C){$C(-1,0)$}
  \tkzLabelPoint[below left](D){$D(0,-1)$}
\end{tikzpicture}
```

## 44. Own style

You can set your own style with `\tkzSetUpStyle`

### 44.1. The macro \tkzSetUpStyle

`\tkzSetUpStyle[⟨local options⟩]`

The options are the same as those of TikZ

#### 44.1.1. Use of \tkzSetUpStyle


```
\begin{tikzpicture}
  \tkzSetUpStyle[color=blue!20!black,fill=blue!20]{mystyle}
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(0,1){A}
  \tkzDrawPoints(O) % general style
  \tkzDrawPoints[mystyle,size=4](A) % my style
  \tkzLabelPoints(O,A)
\end{tikzpicture}
```

## 45. How to use arrows

In some countries, arrows are used to indicate the parallelism of lines, to represent half-lines or the sides of an angle (rays).
Here are some examples of how to place these arrows. **tkz-euclide** loads a library called **arrows.meta**.
`\usetikzlibrary{arrows.meta}`
This library is used to produce different styles of arrow heads. The next examples use some of them.

## 45.1. Arrows at endpoints on segment, ray or line

**Stealth**, **Triangle**, **To**, **Latex** and ...which can be combined with **reversed**. That's easy to place an arrow at one or two endpoints.

1. **-Triangle** and **Segment**



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDrawSegment[-Triangle](A,B)
\end{tikzpicture}
```

2. **Stealth-Stealth** and **Segment**



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDrawSegment[Stealth-Stealth](A,B)
\end{tikzpicture}
```

3. **Latex-Latex** and **Line**



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDrawLine[red,Latex-Latex](A,B)
  \tkzDrawPoints(A,B)
\end{tikzpicture}
```

4. **To-To** and **Segment**



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDrawSegment[To-To](A,B)
\end{tikzpicture}
```

5. **Latex-Late** and **Segment**



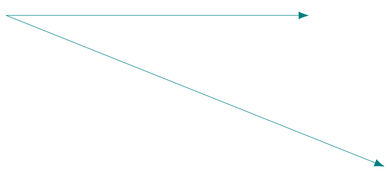
```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDrawSegment[Latex-Latex](A,B)
\end{tikzpicture}
```

6. **Latex-** and **Segment**



```
\begin{tikzpicture}
  \tkzDefPoints{0/0/A,4/0/B}
  \tkzDrawSegment[Latex-](A,B)
\end{tikzpicture}
```

7. **-Latex** and **Segments**



```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,4/0/B,5/-2/C}
 \tkzDrawSegments[-Latex](A,B A,C)
\end{tikzpicture}
```

### 45.1.1. Scaling an arrow head

```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,4/0/B}
 \tkzDrawSegment[{Latex[scale=2]}-{Latex[scale=2]}](A,B)
\end{tikzpicture}
```

### 45.1.2. Using vector style

`\tikzset{vector style/.style={>=Latex,->}}`
You can redefine this style.



```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,4/0/B}
\tkzDrawSegment[vector style](A,B)
\end{tikzpicture}
```

## 45.2. Arrows on middle point of a line segment

Arrows on lines are used to indicate that those lines are parallel. It depends on the country, in France we prefer to indicate outside the figure that $(A,B) \parallel (D,C)$. The code is an adaptation of an answer by **Muzimuzhi Z** on the site tex.stackexchange.com.

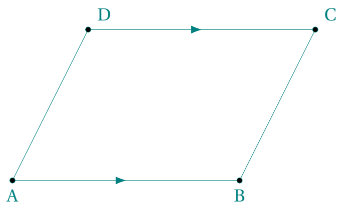
Syntax:

- `tkz arrow` (**Latex** by default)
- `tkz arrow=<arrow end tip>`
- `tkz arrow=<arrow end tip> at <pos> (<pos> = .5 by default)`
- `tkz arrow={<arrow end tip>[<arrow options>] at <pos>}` option possible **scale**

Example usages:

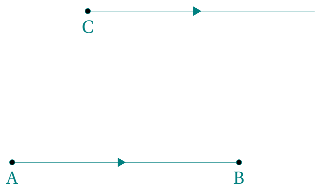
```
\tkzDrawSegment[tkz arrow=Stealth] (A,B)
\tkzDrawSegment[tkz arrow={To[scale=3] at .4}](A,B)
\tkzDrawSegment[tkz arrow={Latex[scale=5,blue] at .6}](A,B)
```

### 45.2.1. In a parallelogram




```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,3/0/B,4/2/C}
 \tkzDefParallelogram(A,B,C)
 \tkzGetPoint{D}
 \tkzDrawSegments[tkz arrow](A,B D,C)
 \tkzDrawSegments(B,C D,A)
 \tkzLabelPoints(A,B)
 \tkzLabelPoints[above right](C,D)
 \tkzDrawPoints(A,...,D)
\end{tikzpicture}
```

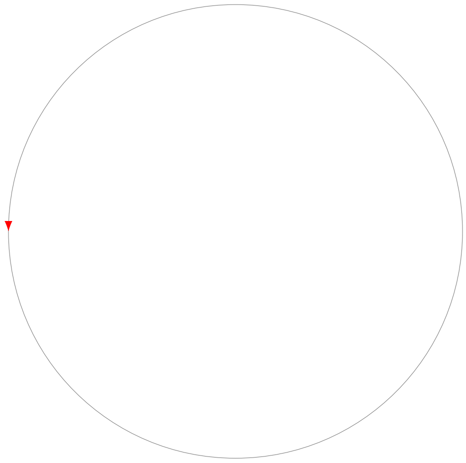
### 45.2.2. A line parallel to another one




```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,3/0/B,1/2/C}
 \tkzDefPointWith[colinear= at C](A,B)
 \tkzGetPoint{D}
 \tkzDrawSegments[tkz arrow=Triangle](A,B C,D)
 \tkzLabelPoints(A,B,C)
 \tkzDrawPoints(A,...,C)
\end{tikzpicture}
```

### 45.2.3. Arrow on a circle

It is possible to place an arrow on the first quarter of a circle. A rotation allows you to move the arrow.

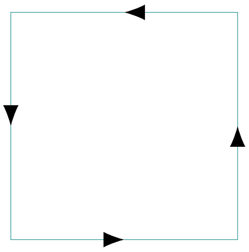


```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,3/0/B}
\begin{scope}[rotate=150]
 \tkzDrawCircle[tkz arrow={Latex[scale=2,red]}](A,B)
\end{scope}
\end{tikzpicture}
```

## 45.3. Arrows on all segments of a polygon

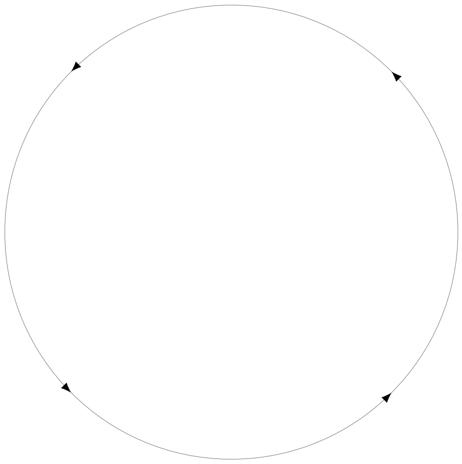
Some users of my package have asked me to be able to place an arrow on each side of a polygon. I used a style proposed by Paul Gaborit on the site tex.stackexchange.com.
`\tikzset{tkz arrows/.style=`
`{postaction={on each path={tkz arrow={Latex[scale=2,color=black]}}}}}`
You can change this style. With **tkz arrows** you can an arrow on each segment of a polygon

### 45.3.1. Arrow on each segment with tkz arrows



```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,3/0/B}
 \tkzDefSquare(A,B) \tkzGetPoints{C}{D}
 \tkzDrawPolygon[tkz arrows](A,...,D)
\end{tikzpicture}
```

### 45.3.2. Using tkz arrows with a circle



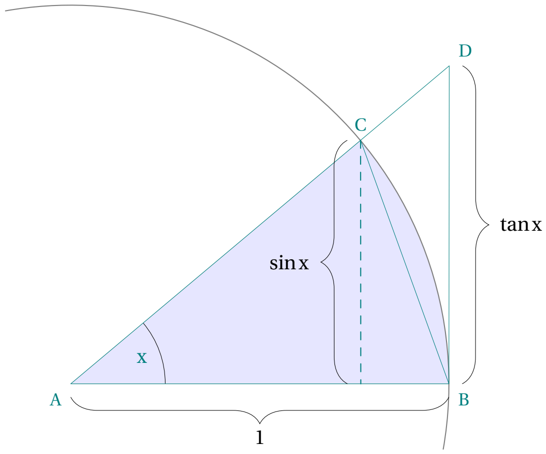
```
\begin{tikzpicture}
 \tkzDefPoints{0/0/A,3/0/B}
 \tkzDrawCircle[tkz arrows](A,B)
\end{tikzpicture}
```

# Part IX.

# Examples

# 46. Different authors

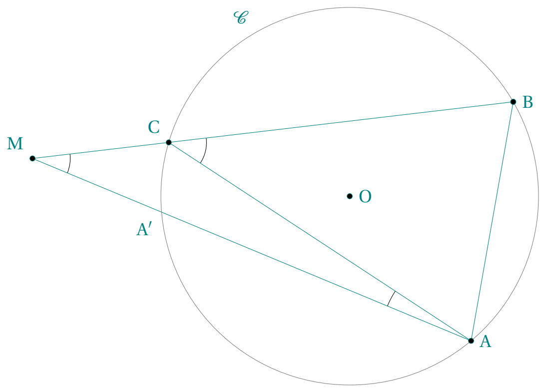
## 46.1. Code from Andrew Swan




```
\begin{tikzpicture}[scale=1.25]
\def\radius{4}
\def\angle{40}
\pgfmathsetmacro{\htan}{tan(\angle)}
\tkzDefPoint(0,0){A} \tkzDefPoint(0,\radius){F}
\tkzDefPoint(\radius,0){B}
\tkzDefPointBy[rotation= center A angle \angle](B)
\tkzGetPoint{C}
\tkzDefLine[perpendicular=through B,K=1](A,B)
\tkzGetPoint{b}
\tkzInterLL(A,C)(B,b) \tkzGetPoint{D}
\tkzDefLine[perpendicular=through C,K=-1](A,B)
\tkzGetPoint{c}
\tkzInterLL(C,c)(A,B) \tkzGetPoint{E}
\tkzDrawSector[fill=blue,opacity=0.1](A,B)(C)
\tkzDrawArc[thin](A,B)(F)
\tkzMarkAngle(B,A,C)
\tkzLabelAngle[pos=0.8](B,A,C){$x$}
\tkzDrawPolygon(A,B,D)
\tkzDrawSegments(C,B)
\tkzDrawSegments[dashed,thin](C,E)
\tkzLabelPoints[below left](A)
\tkzLabelPoints[below right](B)
\tkzLabelPoints[above](C)
\tkzLabelPoints[above right](D)
\begin{scope}[/pgf/decoration/raise=5pt]
\draw [decorate,decoration={brace,mirror,
   amplitude=10pt},xshift=0pt,yshift=-4pt]
(A) -- (B) node [black,midway,yshift=-20pt]
{\footnotesize $1$};
\draw [decorate,decoration={brace,amplitude=10pt},
       xshift=4pt,yshift=0pt]
(D) -- (B) node [black,midway,xshift=27pt]
{\footnotesize $\tan x$};
\draw [decorate,decoration={brace,amplitude=10pt},
       xshift=4pt,yshift=0pt]
(E) -- (C) node [black,midway,xshift=-27pt]
{\footnotesize $\sin x$};
\end{scope}
\end{tikzpicture}
```

## 46.2. Example: Dimitris Kapeta

You need in this example to use `mkpos=.2` with `\tkzMarkAngle` because the measure of $\widehat{CAM}$ is too small. Another possiblity is to use `\tkzFillAngle`.

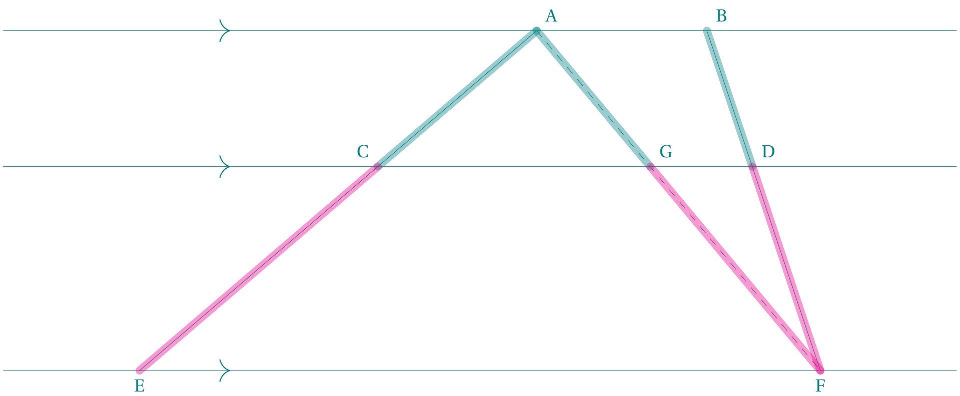



```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(2.5,0){N}
  \tkzDefPoint(-4.2,0.5){M}
  \tkzDefPointBy[rotation=center O angle 30](N)
  \tkzGetPoint{B}
  \tkzDefPointBy[rotation=center O angle -50](N)
  \tkzGetPoint{A}
  \tkzInterLC[common=B](M,B)(O,B) \tkzGetFirstPoint{C}
  \tkzInterLC[common=A](M,A)(O,A) \tkzGetFirstPoint{A'}
  \tkzMarkAngle[mkpos=.2, size=0.5](A,C,B)
  \tkzMarkAngle[mkpos=.2, size=0.5](A,M,C)
  \tkzDrawSegments(A,C M,A M,B A,B)
  \tkzDrawCircle(O,N)
  \tkzLabelCircle[above left](O,N)(120){%
                  $\mathcal{C}$}
  \begin{scope}[veclen]
  \tkzMarkAngle[mkpos=.2, size=1.2](C,A,M)
  \end{scope}
  \tkzDrawPoints(O, A, B, M, B, C)
  \tkzLabelPoints[right](O,A,B)
  \tkzLabelPoints[above left](M,C)
  \tkzLabelPoint[below left](A'){$A'$}
\end{tikzpicture}
```

### 46.3. Example : John Kitzmiller

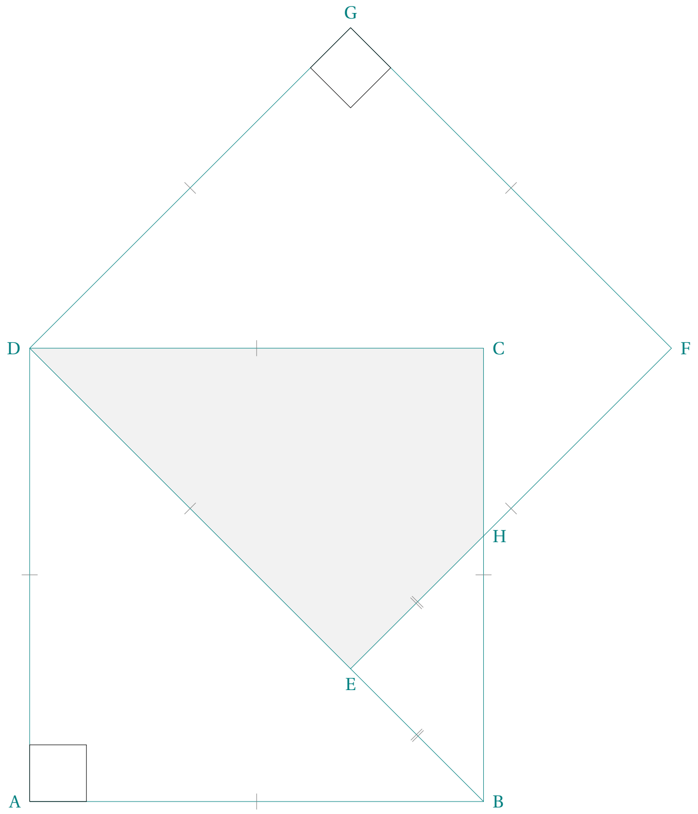
Prove that $\dfrac{AC}{CE} = \dfrac{BD}{DF}$.

Another interesting example from John, you can see how to use some extra options like **decoration** and **postaction** from Ti*k*Z with **tkz-euclide**.



```
\begin{tikzpicture}[scale=1.5,decoration={markings,
  mark=at position 3cm with {\arrow[scale=2]{>}}}]
  \tkzDefPoints{0/0/E, 6/0/F, 0/1.8/P, 6/1.8/Q, 0/3/R, 6/3/S}
  \tkzDrawLines[postaction={decorate}](E,F P,Q R,S)
  \tkzDefPoints{3.5/3/A, 5/3/B}
  \tkzDrawSegments(E,A F,B)
  \tkzInterLL(E,A)(P,Q) \tkzGetPoint{C}
  \tkzInterLL(B,F)(P,Q) \tkzGetPoint{D}
  \tkzLabelPoints[above right](A,B)
  \tkzLabelPoints[below](E,F)
  \tkzLabelPoints[above left](C)
  \tkzDrawSegments[style=dashed](A,F)
  \tkzInterLL(A,F)(P,Q) \tkzGetPoint{G}
  \tkzLabelPoints[above right](D,G)
  \tkzDrawSegments[color=teal, line width=3pt, opacity=0.4](A,C A,G)
  \tkzDrawSegments[color=magenta, line width=3pt, opacity=0.4](C,E G,F)
  \tkzDrawSegments[color=teal, line width=3pt, opacity=0.4](B,D)
  \tkzDrawSegments[color=magenta, line width=3pt, opacity=0.4](D,F)
\end{tikzpicture}
```

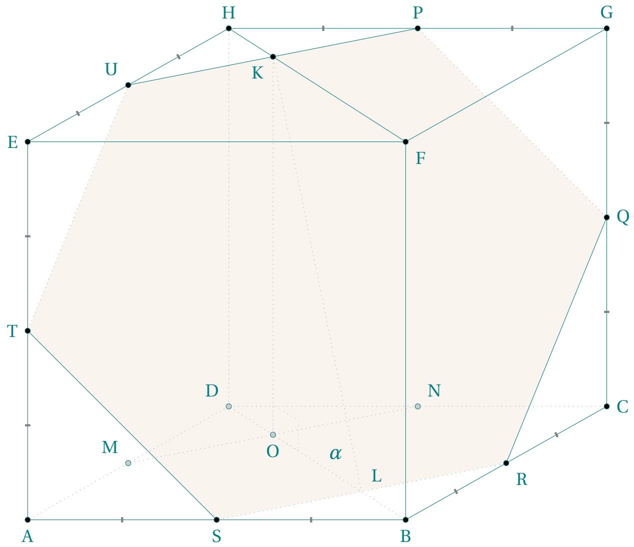
## 46.4. Example 1: from Indonesia



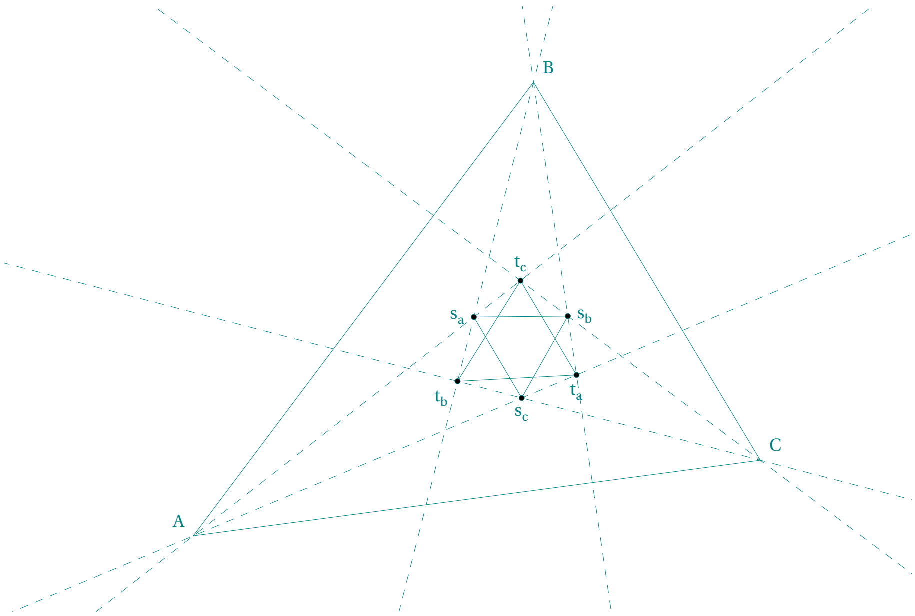
```
\begin{tikzpicture}[scale=3]
   \tkzDefPoints{0/0/A,2/0/B}
   \tkzDefSquare(A,B) \tkzGetPoints{C}{D}
   \tkzDefPointBy[rotation=center D angle 45](C)\tkzGetPoint{G}
   \tkzDefSquare(G,D)\tkzGetPoints{E}{F}
   \tkzInterLL(B,C)(E,F)\tkzGetPoint{H}
   \tkzFillPolygon[gray!10](D,E,H,C,D)
   \tkzDrawPolygon(A,...,D)\tkzDrawPolygon(D,...,G)
   \tkzDrawSegment(B,E)
   \tkzMarkSegments[mark=|,size=3pt,color=gray](A,B B,C C,D D,A E,F F,G G,D D,E)
   \tkzMarkSegments[mark=||,size=3pt,color=gray](B,E E,H)
   \tkzLabelPoints[left](A,D)
   \tkzLabelPoints[right](B,C,F,H)
   \tkzLabelPoints[above](G)\tkzLabelPoints[below](E)
   \tkzMarkRightAngles(D,A,B D,G,F)
\end{tikzpicture}
```

## 46.5. Example 2: from Indonesia

```
  \begin{tikzpicture}[pol/.style={fill=brown!40,opacity=.2},
      seg/.style={tkzdotted,color=gray}, hidden pt/.style={fill=gray!40},
       mra/.style={color=gray!70,tkzdotted,/tkzrightangle/size=.2},scale=2]
  \tkzDefPoints{0/0/A,2.5/0/B,1.33/0.75/D,0/2.5/E,2.5/2.5/F}
  \tkzDefLine[parallel=through D](A,B)  \tkzGetPoint{I1}
  \tkzDefLine[parallel=through B](A,D)  \tkzGetPoint{I2}
  \tkzInterLL(D,I1)(B,I2)               \tkzGetPoint{C}
  \tkzDefLine[parallel=through E](A,D)  \tkzGetPoint{I3}
  \tkzDefLine[parallel=through D](A,E)  \tkzGetPoint{I4}
  \tkzInterLL(E,I3)(D,I4)               \tkzGetPoint{H}
  \tkzDefLine[parallel=through F](E,H)  \tkzGetPoint{I5}
  \tkzDefLine[parallel=through H](E,F)  \tkzGetPoint{I6}
  \tkzInterLL(F,I5)(H,I6)               \tkzGetPoint{G}
  \tkzDefMidPoint(G,H) \tkzGetPoint{P}  \tkzDefMidPoint(G,C) \tkzGetPoint{Q}
  \tkzDefMidPoint(B,C) \tkzGetPoint{R}  \tkzDefMidPoint(A,B) \tkzGetPoint{S}
  \tkzDefMidPoint(A,E) \tkzGetPoint{T}  \tkzDefMidPoint(E,H) \tkzGetPoint{U}
  \tkzDefMidPoint(A,D) \tkzGetPoint{M}  \tkzDefMidPoint(D,C) \tkzGetPoint{N}
  \tkzInterLL(B,D)(S,R)\tkzGetPoint{L} \tkzInterLL(H,F)(U,P) \tkzGetPoint{K}
  \tkzDefLine[parallel=through K](D,H)  \tkzGetPoint{I7}
  \tkzInterLL(K,I7)(B,D)                \tkzGetPoint{O}
  \tkzFillPolygon[pol](P,Q,R,S,T,U)
  \tkzDrawSegments[seg](K,O K,L P,Q R,S T,U C,D H,D A,D M,N B,D)
  \tkzDrawSegments(E,H B,C G,F G,H G,C Q,R S,T U,P H,F)
  \tkzDrawPolygon(A,B,F,E)
  \tkzDrawPoints(A,B,C,E,F,G,H,P,Q,R,S,T,U,K) \tkzDrawPoints[hidden pt](M,N,O,D)
  \tkzMarkRightAngle[mra](L,O,K)
  \tkzMarkSegments[mark=|,size=1pt,thick,color=gray](A,S B,S B,R C,R
                  Q,C Q,G G,P H,P E,U H,U E,T A,T)
  \tkzLabelAngle[pos=.3](K,L,O){$\alpha$}
  \tkzLabelPoints[below](O,A,S,B)    \tkzLabelPoints[above](H,P,G)
  \tkzLabelPoints[left](T,E)         \tkzLabelPoints[right](C,Q)
  \tkzLabelPoints[above left](U,D,M) \tkzLabelPoints[above right](L,N)
  \tkzLabelPoints[below right](F,R)  \tkzLabelPoints[below left](K)
\end{tikzpicture}
```


H
P
G
U
K
E
F
Q
T
D
N
C
M
O
α
L
R
A
S
B

## 46.6. Illustration of the Morley theorem by Nicolas François

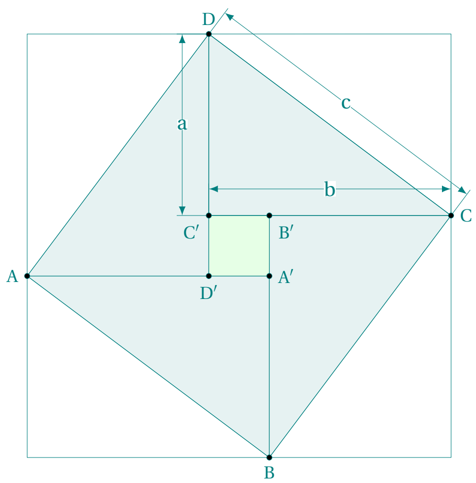



```
\begin{tikzpicture}
  \tkzInit[ymin=-3,ymax=5,xmin=-5,xmax=7]
  \tkzClip
  \tkzDefPoints{-2.5/-2/A,2/4/B,5/-1/C}
  \tkzFindAngle(C,A,B) \tkzGetAngle{anglea}
  \tkzDefPointBy[rotation=center A angle 1*\anglea/3](C) \tkzGetPoint{TA1}
  \tkzDefPointBy[rotation=center A angle 2*\anglea/3](C) \tkzGetPoint{TA2}
  \tkzFindAngle(A,B,C) \tkzGetAngle{angleb}
  \tkzDefPointBy[rotation=center B angle 1*\angleb/3](A) \tkzGetPoint{TB1}
  \tkzDefPointBy[rotation=center B angle 2*\angleb/3](A) \tkzGetPoint{TB2}
  \tkzFindAngle(B,C,A) \tkzGetAngle{anglec}
  \tkzDefPointBy[rotation=center C angle 1*\anglec/3](B) \tkzGetPoint{TC1}
  \tkzDefPointBy[rotation=center C angle 2*\anglec/3](B) \tkzGetPoint{TC2}
  \tkzInterLL(A,TA1)(B,TB2) \tkzGetPoint{U1}
  \tkzInterLL(A,TA2)(B,TB1) \tkzGetPoint{V1}
  \tkzInterLL(B,TB1)(C,TC2) \tkzGetPoint{U2}
  \tkzInterLL(B,TB2)(C,TC1) \tkzGetPoint{V2}
  \tkzInterLL(C,TC1)(A,TA2) \tkzGetPoint{U3}
  \tkzInterLL(C,TC2)(A,TA1) \tkzGetPoint{V3}
  \tkzDrawPolygons(A,B,C U1,U2,U3 V1,V2,V3)
  \tkzDrawLines[add=2 and 2,very thin,dashed](A,TA1 B,TB1 C,TC1 A,TA2 B,TB2 C,TC2)
  \tkzDrawPoints(U1,U2,U3,V1,V2,V3)
  \tkzLabelPoint[left](V1){$s_a$} \tkzLabelPoint[right](V2){$s_b$}
  \tkzLabelPoint[below](V3){$s_c$} \tkzLabelPoint[above left](A){$A$}
  \tkzLabelPoints[above right](B,C) \tkzLabelPoint(U1){$t_a$}
  \tkzLabelPoint[below left](U2){$t_b$} \tkzLabelPoint[above](U3){$t_c$}
\end{tikzpicture}
```

## 46.7. Gou gu theorem / Pythagorean Theorem by Zhao Shuang

**Gou gu theorem / Pythagorean Theorem by Zhao Shuang**

*Pythagoras was not the first person who discovered this theorem around the world. Ancient China discovered this theorem much earlier than him. So there is another name for the Pythagorean theorem in China, the Gou-Gu theorem. Zhao Shuang was an ancient Chinese mathematician. He rediscovered the "Gou gu therorem", which is actually the Chinese version of the "Pythagorean theorem". Zhao Shuang used a method called the "cutting and compensation principle", he created a picture of "Pythagorean Round Square" Below the figure used to illustrate the proof of the "Gou gu theorem." (code from Nan Geng)*

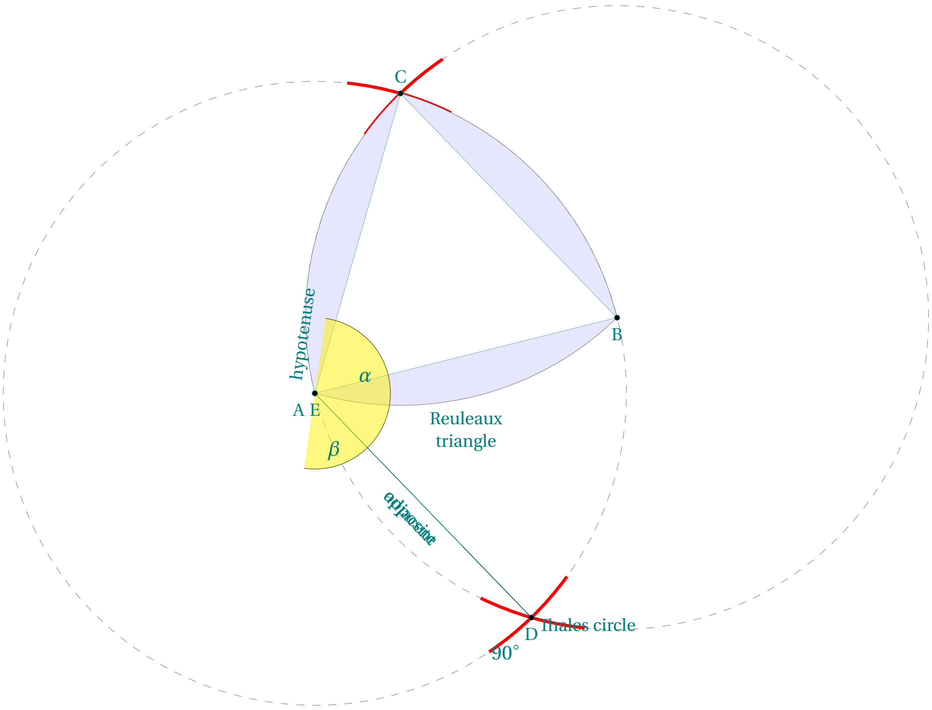



```
\begin{tikzpicture}[scale=.8]
  \tkzDefPoint(0,0){A} \tkzDefPoint(4,0){A'}
  \tkzInterCC[R](A, 5)(A', 3)
  \tkzGetSecondPoint{B}
  \tkzDefSquare(A,B)   \tkzGetPoints{C}{D}
  \tkzCalcLength(A,A') \tkzGetLength{lA}
  \tkzCalcLength(A',B) \tkzGetLength{lB}
  \pgfmathparse{\lA-\lB}
  \tkzInterLC[R](A,A')(A',\pgfmathresult)
  \tkzGetFirstPoint{D'}
  \tkzDefSquare(D',A')\tkzGetPoints{B'}{C'}
  \tkzDefLine[orthogonal=through D](D,D')
   \tkzGetPoint{d}
  \tkzDefLine[orthogonal=through A](A,A')
   \tkzGetPoint{a}
  \tkzDefLine[orthogonal=through C](C,C')
   \tkzGetPoint{c}
  \tkzInterLL(D,d)(C,c) \tkzGetPoint{E}
  \tkzInterLL(D,d)(A,a) \tkzGetPoint{F}
  \tkzDefSquare(E,F)\tkzGetPoints{G}{H}
  \tkzDrawPolygons[fill=teal!10](A,B,A' B,C,B'
     C,D,C' A,D',D)
  \tkzDrawPolygons(A,B,C,D E,F,G,H)
  \tkzDrawPolygon[fill=green!10](A',B',C',D')
  \tkzDrawSegment[dim={$a$,-10pt,}](D,C')
  \tkzDrawSegment[dim={$b$,-10pt,}](C,C')
  \tkzDrawSegment[dim={$c$,-10pt,}](C,D)
  \tkzDrawPoints[size=2](A,B,C,D,A',B',C',D')
  \tkzLabelPoints[left](A)
  \tkzLabelPoints[below](B)
  \tkzLabelPoints[right](C)
  \tkzLabelPoints[above](D)
  \tkzLabelPoints[right](A')
  \tkzLabelPoints[below right](B')
  \tkzLabelPoints[below left](C')
  \tkzLabelPoints[below](D')
 \end{tikzpicture}
```

### 46.8. Reuleaux-Triangle

**Reuleaux-triangle by Stefan Kottwitz**

*A well-known classic field of mathematics is geometry. You may know Euclidean geometry from school, with constructions by compass and ruler. Math teachers may be very interested in drawing geometry constructions and explanations. Underlying constructions can help us with general drawings where we would need intersections and tangents of lines and circles, even if it does not look like geometry. So, here, we will remember school geometry drawings. We will use the tkz-euclide package, which works on top of TikZ. We will construct an equilateral triangle. Then we extend it to get a Reuleaux triangle, and add annotations. The code is fully explained in the LaTeX Cookbook, Chapter 10, Advanced Mathematics, Drawing geometry pictures. Stefan Kottwitz*



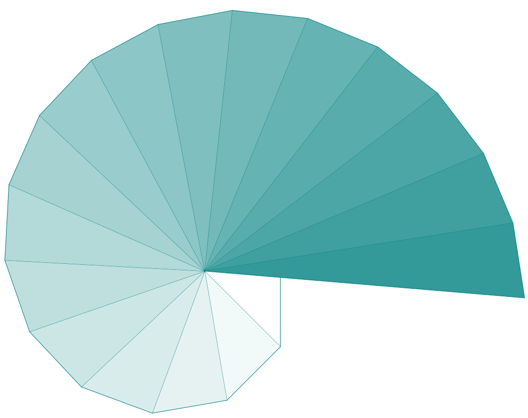
```
\begin{tikzpicture}
  \tkzDefPoint(0,0){A} \tkzDefPoint(4,1){B}
  \tkzInterCC(A,B)(B,A) \tkzGetPoints{C}{D}
  \tkzInterLC(A,B)(B,A) \tkzGetPoints{F}{E}
  \tkzDrawCircles[dashed](A,B B,A)
  \tkzDrawPolygons(A,B,C A,E,D)
  \tkzCompasss[color=red, very thick](A,C B,C A,D B,D)
  \begin{scope}
    \tkzSetUpArc[thick,delta=0]
    \tkzDrawArc[fill=blue!10](A,B)(C)
    \tkzDrawArc[fill=blue!10](B,C)(A)
    \tkzDrawArc[fill=blue!10](C,A)(B)
  \end{scope}
  \tkzMarkAngles(D,A,E A,E,D)
  \tkzFillAngles[fill=yellow,opacity=0.5](D,A,E A,E,D)
  \tkzMarkRightAngle[size=0.65,fill=red!20,opacity=0.2](A,D,E)
  \tkzLabelAngle[pos=0.7](D,A,E){$\alpha$}
  \tkzLabelAngle[pos=0.8](A,E,D){$\beta$}
  \tkzLabelAngle[pos=0.5,xshift=-1.4mm](A,D,D){$90^\circ$}
  \begin{scope}[font=\small]
    \tkzLabelSegment[below=0.6cm,align=center](A,B){Reuleaux\\triangle}
    \tkzLabelSegment[above right,sloped](A,E){hypotenuse}
    \tkzLabelSegment[below,sloped](D,E){opposite}
    \tkzLabelSegment[below,sloped](A,D){adjacent}
    \tkzLabelSegment[below right=4cm](A,E){Thales circle}
  \end{scope}
  \tkzLabelPoints[below left](A)
  \tkzLabelPoints(B,D)
  \tkzLabelPoint[above](C){$C$}
  \tkzLabelPoints(E)
  \tkzDrawPoints(A,...,E)

\end{tikzpicture}
```

# 47. Some interesting examples

## 47.1. Square root of the integers

**Square root of the integers**

*How to get* $1$, $\sqrt{2}$, $\sqrt{3}$ *with a rule and a compass.*

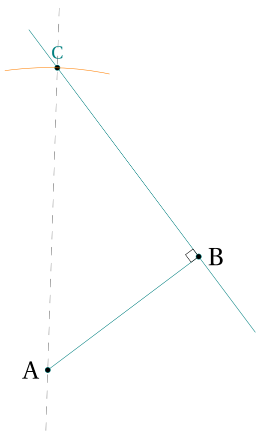


```
\begin{tikzpicture}
  \tkzDefPoint(0,0){O}
  \tkzDefPoint(1,0){a0}
   \tkzDrawSegment(O,a0)
  \foreach \i [count=\j] in {0,...,16}{%
    \tkzDefPointWith[orthogonal normed](a\i,O)
    \tkzGetPoint{a\j}
       \pgfmathsetmacro{\c}{5*\i}
    \tkzDrawPolySeg[fill=teal!\c](a\i,a\j,O)}
 \end{tikzpicture}
```

### 47.2. About right triangle

**About right triangle**

*We have a segment* [AB] *and we want to determine a point* C *such that* AC = 8 *cm and* ABC *is a right triangle in* B.

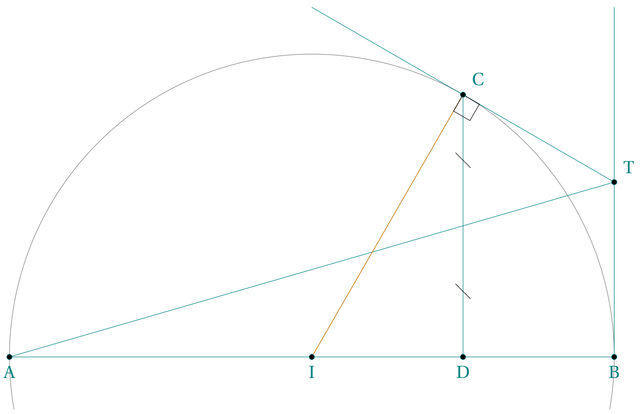



```
\begin{tikzpicture}[scale=.5]
  \tkzDefPoint["$A$" left](2,1){A}
  \tkzDefPoint["$B$" right](6,4){B}
  \tkzDefPointWith[orthogonal,K=-1](B,A)
  \tkzDrawLine[add = .5 and .5](B,tkzPointResult)
  \tkzInterLC[R](B,tkzPointResult)(A,8)
  \tkzGetPoints{J}{C}
  \tkzDrawSegment(A,B)
  \tkzDrawPoints(A,B,C)
  \tkzCompass(A,C)
  \tkzMarkRightAngle(A,B,C)
  \tkzDrawLine[color=gray,style=dashed](A,C)
  \tkzLabelPoint[above](C){$C$}
\end{tikzpicture}
```

### 47.3. Archimedes

**Archimedes**

*This is an ancient problem proved by the great Greek mathematician Archimedes . The figure below shows a semicircle, with diameter* AB. *A tangent line is drawn and touches the semicircle at* B. *An other tangent line at a point,* C, *on the semicircle is drawn. We project the point* C *on the line segment* [AB] *on a point* D. *The two tangent lines intersect at the point* T. *Prove that the line* (AT) *bisects* (CD)

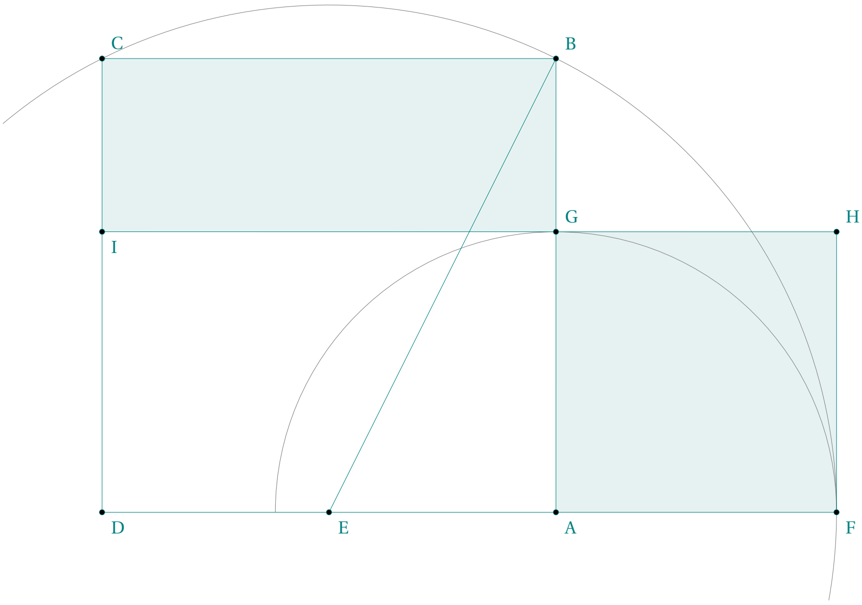


```
\begin{tikzpicture}[scale=1]
  \tkzDefPoint(0,0){A}\tkzDefPoint(6,0){D}
  \tkzDefPoint(8,0){B}\tkzDefPoint(4,0){I}
  \tkzDefLine[orthogonal=through D](A,D)
  \tkzInterLC[R](D,tkzPointResult)(I,4) \tkzGetSecondPoint{C}
  \tkzDefLine[orthogonal=through C](I,C)    \tkzGetPoint{c}
  \tkzDefLine[orthogonal=through B](A,B)    \tkzGetPoint{b}
  \tkzInterLL(C,c)(B,b) \tkzGetPoint{T}
  \tkzInterLL(A,T)(C,D) \tkzGetPoint{P}
  \tkzDrawArc(I,B)(A)
  \tkzDrawSegments(A,B A,T C,D I,C) \tkzDrawSegment[new](I,C)
  \tkzDrawLine[add = 1 and 0](C,T)   \tkzDrawLine[add = 0 and 1](B,T)
  \tkzMarkRightAngle(I,C,T)
  \tkzDrawPoints(A,B,I,D,C,T)
  \tkzLabelPoints(A,B,I,D)  \tkzLabelPoints[above right](C,T)
  \tkzMarkSegment[pos=.25,mark=s|](C,D) \tkzMarkSegment[pos=.75,mark=s|](C,D)
\end{tikzpicture}
```

### 47.3.1. Square and rectangle of same area; Golden section

**Book II, proposition XI _Euclid's Elements_**

*To construct Square and rectangle of same area.*

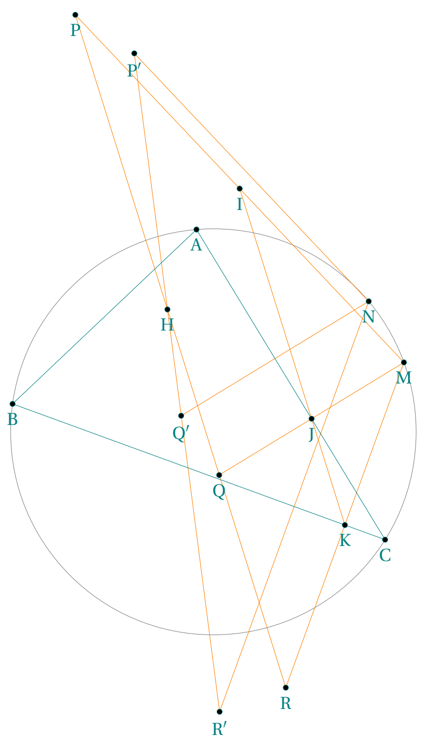



```
\begin{tikzpicture}[scale=.75]
 \tkzDefPoint(0,0){D} \tkzDefPoint(8,0){A}
 \tkzDefSquare(D,A) \tkzGetPoints{B}{C}
 \tkzDefMidPoint(D,A) \tkzGetPoint{E}
 \tkzInterLC(D,A)(E,B)\tkzGetSecondPoint{F}
 \tkzInterLC[near](B,A)(A,F)\tkzGetFirstPoint{G}
 \tkzDefSquare(A,F)\tkzGetFirstPoint{H}
 \tkzInterLL(C,D)(H,G)\tkzGetPoint{I}
 \tkzFillPolygon[teal!10](I,G,B,C)
 \tkzFillPolygon[teal!10](A,F,H,G)
 \tkzDrawArc[angles](E,B)(0,120)
 \tkzDrawSemiCircle(A,F)
 \tkzDrawSegments(A,F E,B H,I F,H)
 \tkzDrawPolygons(A,B,C,D)
 \tkzDrawPoints(A,...,I)
 \tkzLabelPoints[below right](A,E,D,F,I)
 \tkzLabelPoints[above right](C,B,G,H)
\end{tikzpicture}
```

### 47.3.2. Steiner Line and Simson Line

**Steiner Line and Simson Line**

*Consider the triangle ABC and a point M on its circumcircle. The projections of M on the sides of the triangle are on a line (Steiner Line), The three closest points to M on lines AB, AC, and BC are collinear. It's the Simson Line.*

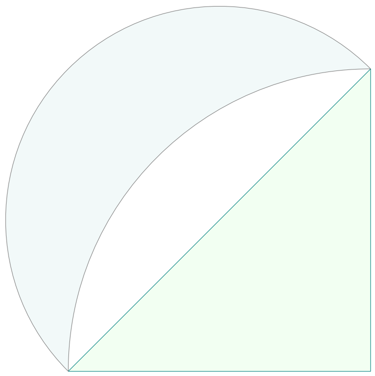



```
\begin{tikzpicture}[scale=.75,rotate=-20]
  \tkzDefPoint(0,0){B}
  \tkzDefPoint(2,4){A} \tkzDefPoint(7,0){C}
  \tkzDefCircle[circum](A,B,C)
  \tkzGetPoint{O}
  \tkzDrawCircle(O,A)
  \tkzCalcLength(O,A)
  \tkzGetLength{rOA}
  \tkzDefShiftPoint[O](40:\rOA){M}
  \tkzDefShiftPoint[O](60:\rOA){N}
  \tkzDefTriangleCenter[orthic](A,B,C)
  \tkzGetPoint{H}
  \tkzDefSpcTriangle[orthic,name=H](A,B,C){a,b,c}
  \tkzDefPointsBy[reflection=over A--B](M,N){P,P'}
  \tkzDefPointsBy[reflection=over A--C](M,N){Q,Q'}
  \tkzDefPointsBy[reflection=over C--B](M,N){R,R'}
  \tkzDefMidPoint(M,P)\tkzGetPoint{I}
  \tkzDefMidPoint(M,Q)\tkzGetPoint{J}
  \tkzDefMidPoint(M,R)\tkzGetPoint{K}
  \tkzDrawSegments[new](P,R M,P M,Q M,R N,P'%
   N,Q' N,R' P',R' I,K)
  \tkzDrawPolygons(A,B,C)
  \tkzDrawPoints(A,B,C,H,M,N,P,Q,R,P',Q',R',I,J,K)
  \tkzLabelPoints(A,B,C,H,M,N,P,Q,R,P',Q',R',I,J,K)
\end{tikzpicture}
```

### 47.4. Lune of Hippocrates

**Lune of Hippocrates**

*From wikipedia : In geometry, the lune of Hippocrates, named after Hippocrates of Chios, is a lune bounded by arcs of two circles, the smaller of which has as its diameter a chord spanning a right angle on the larger circle.In the first figure, the area of the lune is equal to the area of the triangle ABC. Hippocrates of Chios (ancient Greek mathematician,)*

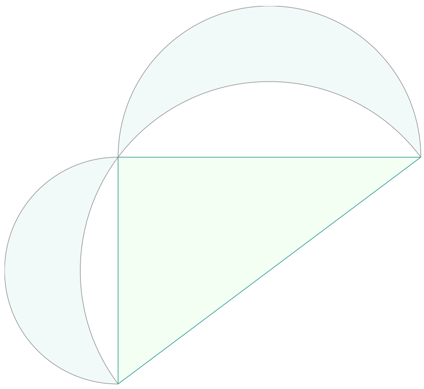


```
\begin{tikzpicture}
 \tkzInit[xmin=-2,xmax=5,ymin=-1,ymax=6]
 \tkzClip % allows you to define a bounding box
   % large enough
  \tkzDefPoint(0,0){A}\tkzDefPoint(4,0){B}
  \tkzDefSquare(A,B)
  \tkzGetFirstPoint{C}
  \tkzDrawPolygon[fill=green!5](A,B,C)
   \begin{scope}
     \tkzClipCircle[out](B,A)
     \tkzDefMidPoint(C,A) \tkzGetPoint{M}
     \tkzDrawSemiCircle[fill=teal!5](M,C)
   \end{scope}
   \tkzDrawArc[delta=0](B,C)(A)
\end{tikzpicture}
```

### 47.5. Lunes of Hasan Ibn al-Haytham

**Lune of Hippocrates**

*From wikipedia : the Arab mathematician Hasan Ibn al-Haytham (Latinized name Alhazen) showed that two lunes, formed on the two sides of a right triangle, whose outer boundaries are semicircles and whose inner boundaries are formed by the circumcircle of the triangle, then the areas of these two lunes added together are equal to the area of the triangle. The lunes formed in this way from a right triangle are known as the lunes of Alhazen.*

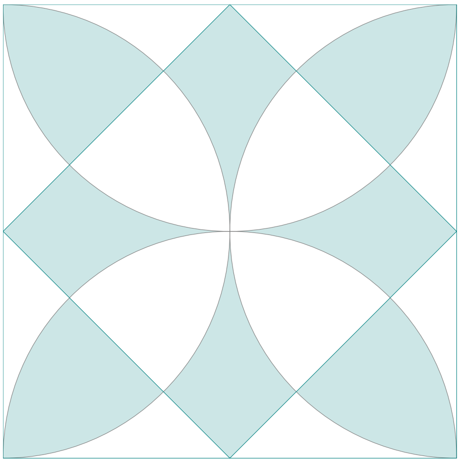


```
\begin{tikzpicture}[scale=.5,rotate=180]
  \tkzInit[xmin=-1,xmax=11,ymin=-4,ymax=7]
  \tkzClip
  \tkzDefPoints{0/0/A,8/0/B}
  \tkzDefTriangle[pythagore,swap](A,B)
  \tkzGetPoint{C}
  \tkzDrawPolygon[fill=green!5](A,B,C)
  \tkzDefMidPoint(C,A) \tkzGetPoint{I}
  \begin{scope}
    \tkzClipCircle[out](I,A)
    \tkzDefMidPoint(B,A) \tkzGetPoint{x}
    \tkzDrawSemiCircle[fill=teal!5](x,A)
    \tkzDefMidPoint(B,C) \tkzGetPoint{y}
    \tkzDrawSemiCircle[fill=teal!5](y,B)
  \end{scope}
  \tkzSetUpCompass[/tkzcompass/delta=0]
      \tkzDefMidPoint(C,A) \tkzGetPoint{z}
  \tkzDrawSemiCircle(z,A)
\end{tikzpicture}
```

## 47.6. About clipping circles

**About clipping circles**

*The problem is the management of the bounding box. First you have to define a rectangle in which the figure will be inserted. This is done with the first two lines.*



```
\begin{tikzpicture}
  \tkzInit[xmin=0,xmax=6,ymin=0,ymax=6]
  \tkzClip
  \tkzDefPoints{0/0/A, 6/0/B}
  \tkzDefSquare(A,B)      \tkzGetPoints{C}{D}
  \tkzDefMidPoint(A,B)        \tkzGetPoint{M}
  \tkzDefMidPoint(A,D)        \tkzGetPoint{N}
  \tkzDefMidPoint(B,C)        \tkzGetPoint{O}
  \tkzDefMidPoint(C,D)        \tkzGetPoint{P}
 \begin{scope}
  \tkzClipCircle[out](M,B) \tkzClipCircle[out](P,D)
  \tkzFillPolygon[teal!20](M,N,P,O)
 \end{scope}
 \begin{scope}
   \tkzClipCircle[out](N,A) \tkzClipCircle[out](O,C)
   \tkzFillPolygon[teal!20](M,N,P,O)
 \end{scope}
 \begin{scope}
   \tkzClipCircle(P,C) \tkzClipCircle(N,A)
   \tkzFillPolygon[teal!20](N,P,D)
 \end{scope}
 \begin{scope}
     \tkzClipCircle(O,C) \tkzClipCircle(P,C)
     \tkzFillPolygon[teal!20](P,C,O)
 \end{scope}
 \begin{scope}
     \tkzClipCircle(M,B)  \tkzClipCircle(O,B)
     \tkzFillPolygon[teal!20](O,B,M)
 \end{scope}
 \begin{scope}
     \tkzClipCircle(N,A) \tkzClipCircle(M,A)
     \tkzFillPolygon[teal!20](A,M,N)
 \end{scope}
 \tkzDrawSemiCircles(M,B N,A O,C P,D)
 \tkzDrawPolygons(A,B,C,D M,N,P,O)
 \end{tikzpicture}
```

### 47.7. Similar isosceles triangles

**Similar isosceles triangles**

*The following is from the excellent site* ***Descartes et les Mathématiques****. I did not modify the text and I am only the author of the programming of the figures.* http://debart.pagesperso-orange.fr/seconde/triangle.html

The following is from the excellent site **Descartes et les Mathématiques**. I did not modify the text and I am only the author of the programming of the figures.
http://debart.pagesperso-orange.fr/seconde/triangle.html
Bibliography:

- Géométrie au Bac - Tangente, special issue no. 8 - Exercise 11, page 11
- Elisabeth Busser and Gilles Cohen: 200 nouveaux problèmes du "Monde" - POLE 2007 (200 new problems of "Le Monde")
- Affaire de logique n° 364 - Le Monde February 17, 2004

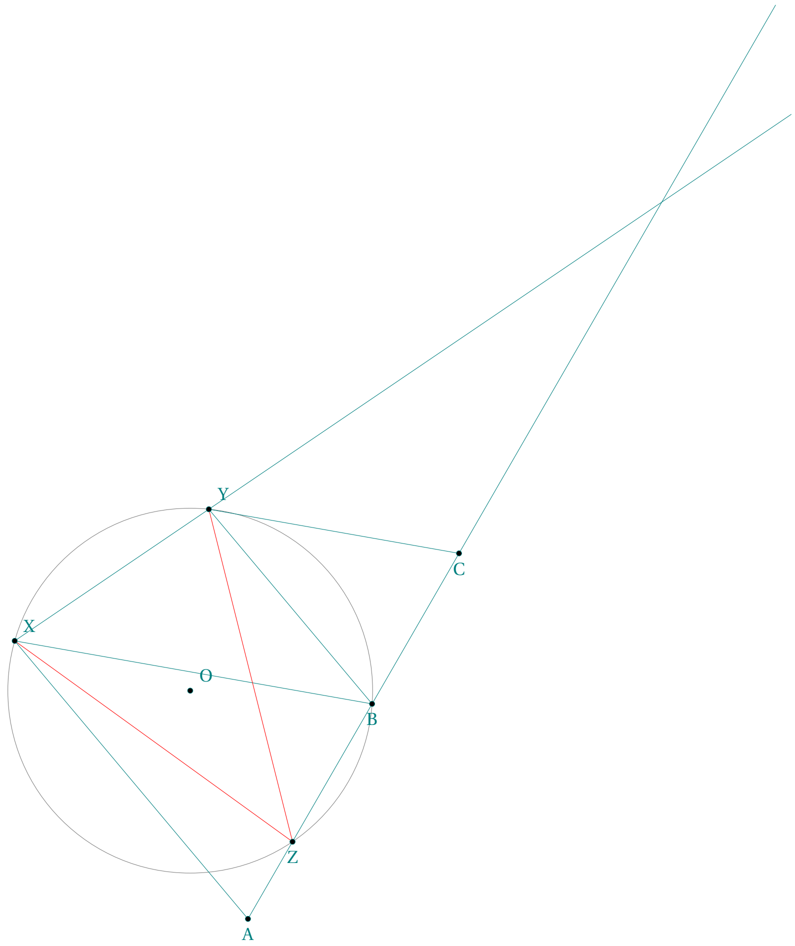
Two statements were proposed, one by the magazine *Tangente* and the other by *Le Monde*.

*Editor of the magazine "Tangente"*: Two similar isosceles triangles AXB and BYC are constructed with main vertices X and Y, such that A, B and C are aligned and that these triangles are "indirect". Let $\alpha$ be the angle at vertex $\widehat{AXB} = \widehat{BYC}$. We then construct a third isosceles triangle XZY similar to the first two, with main vertex Z and "indirect". We ask to demonstrate that point Z belongs to the straight line (AC).

*Editor of "Le Monde"*: We construct two similar isosceles triangles AXB and BYC with principal vertices X and Y, such that A, B and C are aligned and that these triangles are "indirect". Let $\alpha$ be the angle at vertex $\widehat{AXB} = \widehat{BYC}$. The point Z of the line segment [AC] is equidistant from the two vertices X and Y.
At what angle does he see these two vertices?

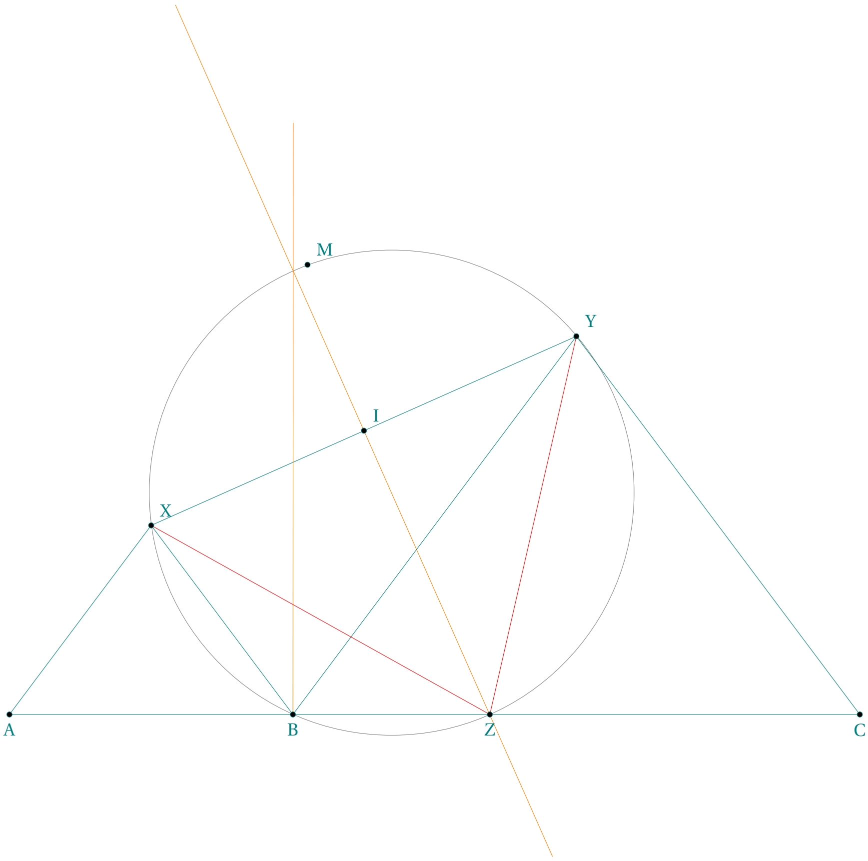
The constructions and their associated codes are on the next two pages, but you can search before looking. The programming respects (it seems to me ...) my reasoning in both cases.

## 47.8. Revised version of "Tangente"




```
\begin{tikzpicture}[scale=.8,rotate=60]
  \tkzDefPoint(6,0){X}   \tkzDefPoint(3,3){Y}
  \tkzDefShiftPoint[X](-110:6){A}    \tkzDefShiftPoint[X](-70:6){B}
  \tkzDefShiftPoint[Y](-110:4.2){A'} \tkzDefShiftPoint[Y](-70:4.2){B'}
  \tkzDefPointBy[translation= from A' to B ](Y) \tkzGetPoint{Y}
  \tkzDefPointBy[translation= from A' to B ](B') \tkzGetPoint{C}
  \tkzInterLL(A,B)(X,Y) \tkzGetPoint{O}
  \tkzDefMidPoint(X,Y) \tkzGetPoint{I}
  \tkzDefPointWith[orthogonal](I,Y)
  \tkzInterLL(I,tkzPointResult)(A,B) \tkzGetPoint{Z}
  \tkzDefCircle[circum](X,Y,B) \tkzGetPoint{O}
  \tkzDrawCircle(O,X)
  \tkzDrawLines[add = 0 and 1.5](A,C) \tkzDrawLines[add = 0 and 3](X,Y)
  \tkzDrawSegments(A,X B,X B,Y C,Y)   \tkzDrawSegments[color=red](X,Z Y,Z)
  \tkzDrawPoints(A,B,C,X,Y,O,Z)
  \tkzLabelPoints(A,B,C,Z)   \tkzLabelPoints[above right](X,Y,O)
\end{tikzpicture}
```

### 47.9. "Le Monde" version

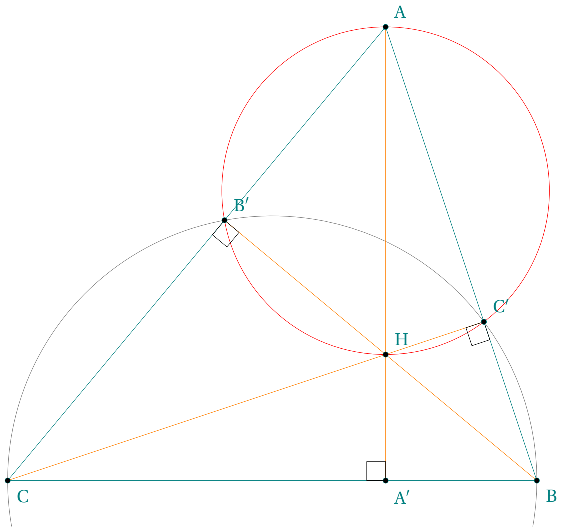



```
\begin{tikzpicture}[scale=1.25]
  \tkzDefPoint(0,0){A}
  \tkzDefPoint(3,0){B}
  \tkzDefPoint(9,0){C}
  \tkzDefPoint(1.5,2){X}
  \tkzDefPoint(6,4){Y}
  \tkzDefCircle[circum](X,Y,B) \tkzGetPoint{O}
  \tkzDefMidPoint(X,Y)               \tkzGetPoint{I}
  \tkzDefPointWith[orthogonal](I,Y)  \tkzGetPoint{i}
  \tkzDrawLines[add = 2 and 1,color=orange](I,i)
  \tkzInterLL(I,i)(A,B)              \tkzGetPoint{Z}
  \tkzInterLC(I,i)(O,B)              \tkzGetFirstPoint{M}
  \tkzDefPointWith[orthogonal](B,Z)  \tkzGetPoint{b}
  \tkzDrawCircle(O,B)
  \tkzDrawLines[add = 0 and 2,color=orange](B,b)
  \tkzDrawSegments(A,X B,X B,Y C,Y A,C X,Y)
  \tkzDrawSegments[color=red](X,Z Y,Z)
  \tkzDrawPoints(A,B,C,X,Y,Z,M,I)
  \tkzLabelPoints(A,B,C,Z)
  \tkzLabelPoints[above right](X,Y,M,I)
\end{tikzpicture}
```

### 47.10. Triangle altitudes

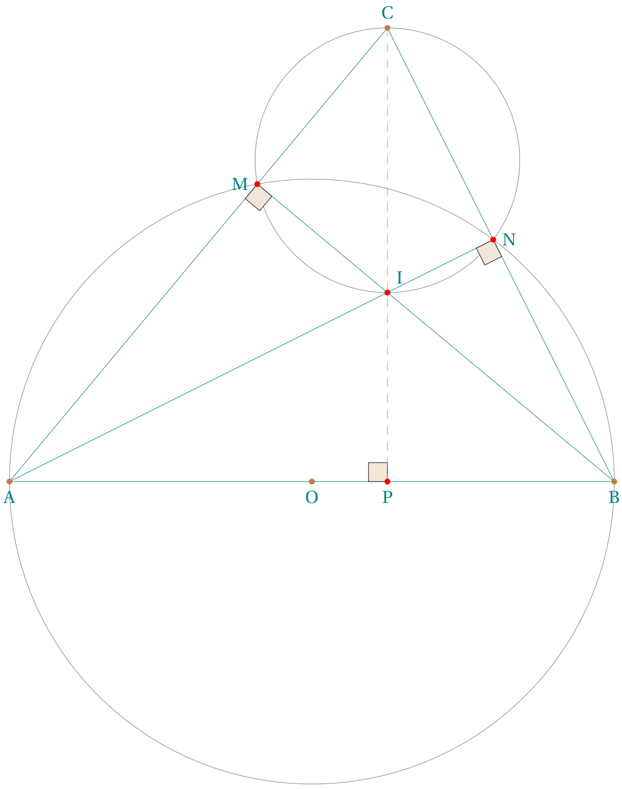
**Triangle altitudes**

*From Wikipedia : The following is again from the excellent site* ***Descartes et les Mathématiques*** *(Descartes and the Mathematics).* `http://debart.pagesperso-orange.fr/geoplan/geometrie_triangle.html`*. The three altitudes of a triangle intersect at the same H-point.*




```
\begin{tikzpicture}
   \tkzDefPoint(0,0){C} \tkzDefPoint(7,0){B}
   \tkzDefPoint(5,6){A}
   \tkzDefMidPoint(C,B) \tkzGetPoint{I}
   \tkzInterLC(A,C)(I,B)
   \tkzGetFirstPoint{B'}
   \tkzInterLC(A,B)(I,B)
   \tkzGetSecondPoint{C'}
   \tkzInterLL(B,B')(C,C') \tkzGetPoint{H}
   \tkzInterLL(A,H)(C,B) \tkzGetPoint{A'}
   \tkzDefCircle[circum](A,B',C') \tkzGetPoint{O}
   \tkzDrawArc(I,B)(C)
   \tkzDrawPolygon(A,B,C)
   \tkzDrawCircle[color=red](O,A)
   \tkzDrawSegments[color=orange](B,B' C,C' A,A')
   \tkzMarkRightAngles(C,B',B B,C',C C,A',A)
   \tkzDrawPoints(A,B,C,A',B',C',H)
   \tkzLabelPoints[above right](A,B',C',H)
   \tkzLabelPoints[below right](B,C,A')
\end{tikzpicture}
```

### 47.11. Altitudes - other construction

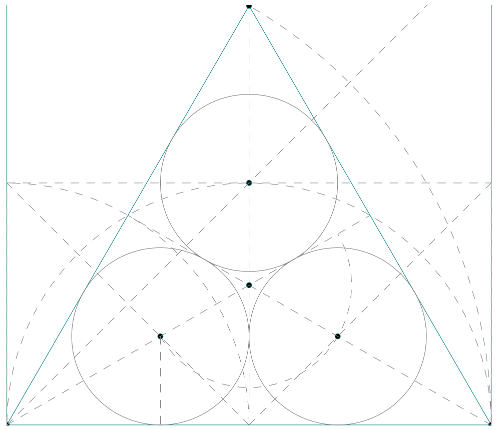



```
\begin{tikzpicture}
\tkzDefPoint(0,0){A} \tkzDefPoint(8,0){B}
\tkzDefPoint(5,6){C}
\tkzDefMidPoint(A,B)\tkzGetPoint{O}
\tkzDefPointBy[projection=onto A--B](C) \tkzGetPoint{P}
\tkzInterLC[common=A](C,A)(O,A)
\tkzGetFirstPoint{M}
\tkzInterLC(C,B)(O,A)
\tkzGetSecondPoint{N}
\tkzInterLL(B,M)(A,N)\tkzGetPoint{I}
\tkzDefCircle[diameter](A,B)\tkzGetPoint{x}
\tkzDefCircle[diameter](I,C)\tkzGetPoint{y}
\tkzDrawCircles(x,A y,C)
\tkzDrawSegments(C,A C,B A,B B,M A,N)
\tkzMarkRightAngles[fill=brown!20](A,M,B A,N,B A,P,C)
\tkzDrawSegment[style=dashed,color=orange](C,P)
\tkzLabelPoints(O,A,B,P)
\tkzLabelPoint[left](M){$M$}
\tkzLabelPoint[right](N){$N$}
\tkzLabelPoint[above](C){$C$}
\tkzLabelPoint[above right](I){$I$}
\tkzDrawPoints[color=red](M,N,P,I)
\tkzDrawPoints[color=brown](O,A,B,C)
\end{tikzpicture}
```

### 47.12. Three circles in an Equilateral Triangle

**Three circles in an Equilateral Triangle**

*From Wikipedia : In geometry, the Malfatti circles are three circles inside a given triangle such that each circle is tangent to the other two and to two sides of the triangle. They are named after Gian Francesco Malfatti, who made early studies of the problem of constructing these circles in the mistaken belief that they would have the largest possible total area of any three disjoint circles within the triangle. Below is a study of a particular case with an equilateral triangle and three identical circles.*

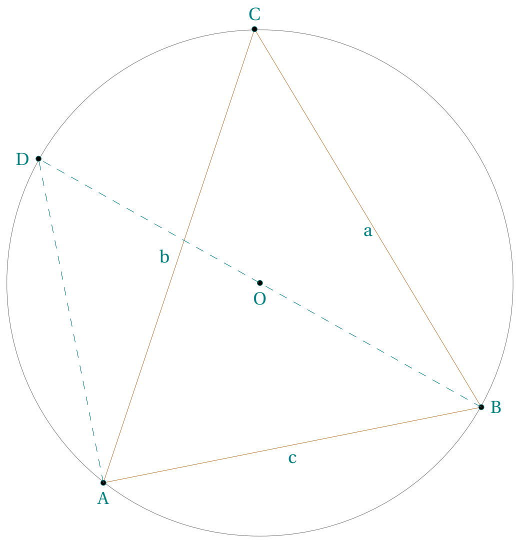


```
\begin{tikzpicture}[scale=.8]
  \tkzDefPoints{0/0/A,8/0/B,0/4/a,8/4/b,8/8/c}
  \tkzDefTriangle[equilateral](A,B) \tkzGetPoint{C}
  \tkzDefMidPoint(A,B) \tkzGetPoint{M}
  \tkzDefMidPoint(B,C) \tkzGetPoint{N}
  \tkzDefMidPoint(A,C) \tkzGetPoint{P}
  \tkzInterLL(A,N)(M,a) \tkzGetPoint{Ia}
  \tkzDefPointBy[projection = onto A--B](Ia)
  \tkzGetPoint{ha}
  \tkzInterLL(B,P)(M,b) \tkzGetPoint{Ib}
  \tkzDefPointBy[projection = onto A--B](Ib)
  \tkzGetPoint{hb}
  \tkzInterLL(A,c)(M,C) \tkzGetPoint{Ic}
  \tkzDefPointBy[projection = onto A--C](Ic)
  \tkzGetPoint{hc}
  \tkzInterLL(A,Ia)(B,Ib) \tkzGetPoint{G}
  \tkzDefSquare(A,B) \tkzGetPoints{D}{E}
  \tkzDrawPolygon(A,B,C)
  \tkzClipBB
  \tkzDrawSemiCircles[gray,dashed](M,B A,M
  A,B B,A G,Ia)
  \tkzDrawCircles[gray](Ia,ha Ib,hb Ic,hc)
  \tkzDrawPolySeg(A,E,D,B)
  \tkzDrawPoints(A,B,C,G,Ia,Ib,Ic)
  \tkzDrawSegments[gray,dashed](C,M A,N B,P
   M,a M,b A,a a,b b,B A,D Ia,ha)
\end{tikzpicture}
```

### 47.13. Law of sines

**Law of sines**

From wikipedia : *In trigonometry, the law of sines, sine law, sine formula, or sine rule is an equation relating the lengths of the sides of a triangle (any shape) to the sines of its angles.*




```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,5/1/B,2/6/C}
\tkzDefTriangleCenter[circum](A,B,C)
 \tkzGetPoint{O}
\tkzDefPointBy[symmetry= center O](B)
 \tkzGetPoint{D}
\tkzDrawPolygon[color=brown](A,B,C)
\tkzDrawCircle(O,A)
\tkzDrawPoints(A,B,C,D,O)
\tkzDrawSegments[dashed](B,D A,D)
\tkzLabelPoint[left](D){$D$}
\tkzLabelPoint[below](A){$A$}
\tkzLabelPoint[above](C){$C$}
\tkzLabelPoint[right](B){$B$}
\tkzLabelPoint[below](O){$O$}
\tkzLabelSegment(B,C){$a$}
\tkzLabelSegment[left](A,C){$b$}
\tkzLabelSegment(A,B){$c$}
\end{tikzpicture}
```

In the triangle ABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \tag{1}$$

$$\widehat{C} = \widehat{D}$$

$$\frac{c}{2R} = \sin D = \sin C \tag{2}$$

Then

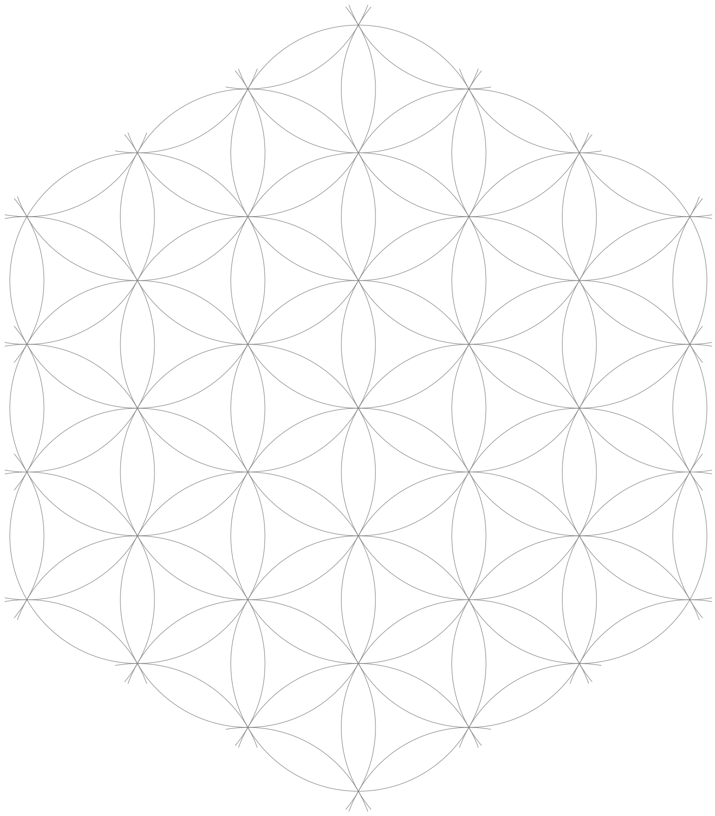
$$\frac{c}{\sin C} = 2R$$

### 47.14. Flower of Life

Book IV, proposition XI _Euclid's Elements_

*Sacred geometry can be described as a belief system attributing a religious or cultural value to many of the fundamental forms of space and time. According to this belief system, the basic patterns of existence are perceived as sacred because in contemplating them one is contemplating the origin of all things. By studying the nature of these forms and their relationship to each other, one may seek to gain insight into the scientific, philosophical, psychological, aesthetic and mystical laws of the universe. The Flower of Life is considered to be a symbol of sacred geometry, said to contain ancient, religious value depicting the fundamental forms of space and time. In this sense, it is a visual expression of the connections life weaves through all mankind, believed by some to contain a type of Akashic Record of basic information of all living things.*

One of the beautiful arrangements of circles found at the Temple of Osiris at Abydos, Egypt (Rawles 1997). Weisstein, Eric W. "Flower of Life." From MathWorld–A Wolfram Web Resource.
http://mathworld.wolfram.com/FlowerofLife.html

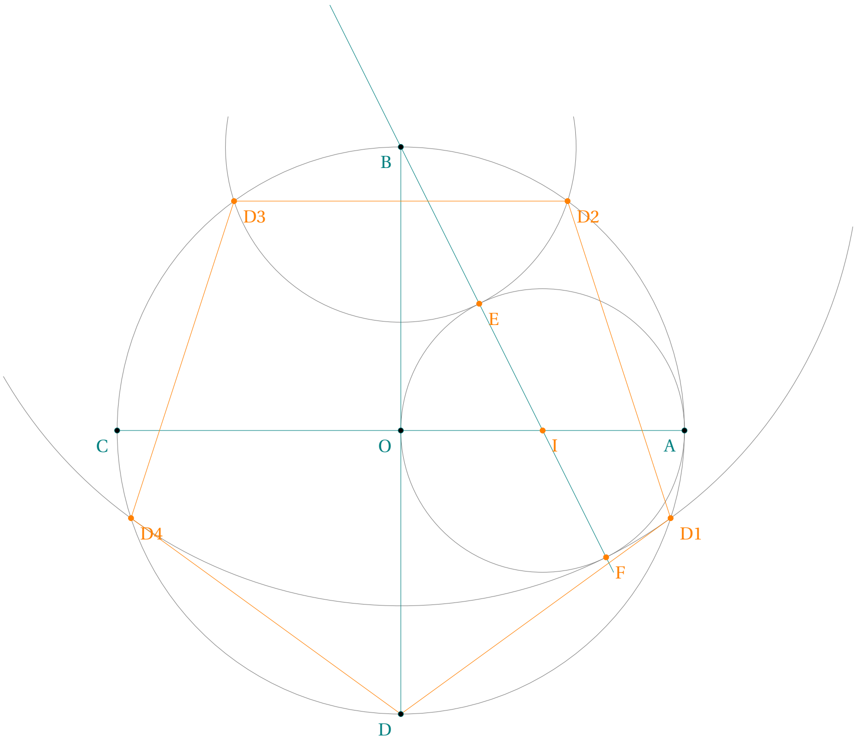


```
\begin{tikzpicture}[scale=.75]
  \tkzSetUpLine[line width=2pt,color=teal!80!black]
  \tkzSetUpCompass[line width=2pt,color=teal!80!black]
   \tkzDefPoint(0,0){O}  \tkzDefPoint(2.25,0){A}
   \tkzDrawCircle(O,A)
\foreach \i in {0,...,5}{
   \tkzDefPointBy[rotation= center O angle 30+60*\i](A)\tkzGetPoint{a\i}
   \tkzDefPointBy[rotation= center {a\i} angle  120](O)\tkzGetPoint{b\i}
   \tkzDefPointBy[rotation= center {a\i} angle  180](O)\tkzGetPoint{c\i}
   \tkzDefPointBy[rotation= center {c\i} angle  120](a\i)\tkzGetPoint{d\i}
   \tkzDefPointBy[rotation= center {c\i} angle   60](d\i)\tkzGetPoint{f\i}
   \tkzDefPointBy[rotation= center {d\i} angle   60](b\i)\tkzGetPoint{e\i}
   \tkzDefPointBy[rotation= center {f\i} angle   60](d\i)\tkzGetPoint{g\i}
   \tkzDefPointBy[rotation= center {d\i} angle   60](e\i)\tkzGetPoint{h\i}
   \tkzDefPointBy[rotation= center {e\i} angle  180](b\i)\tkzGetPoint{k\i}
   \tkzDrawCircle(a\i,O)
   \tkzDrawCircle(b\i,a\i)
   \tkzDrawCircle(c\i,a\i)
   \tkzDrawArc[rotate](f\i,d\i)(-120)
   \tkzDrawArc[rotate](e\i,d\i)(180)
   \tkzDrawArc[rotate](d\i,f\i)(180)
   \tkzDrawArc[rotate](g\i,f\i)(60)
   \tkzDrawArc[rotate](h\i,d\i)(60)
   \tkzDrawArc[rotate](k\i,e\i)(60)
}
   \tkzClipCircle(O,f0)
\end{tikzpicture}
```

### 47.15. Pentagon in a circle

**Book IV, proposition XI _Euclid's Elements_**

*To inscribe an equilateral and equiangular pentagon in a given circle.*

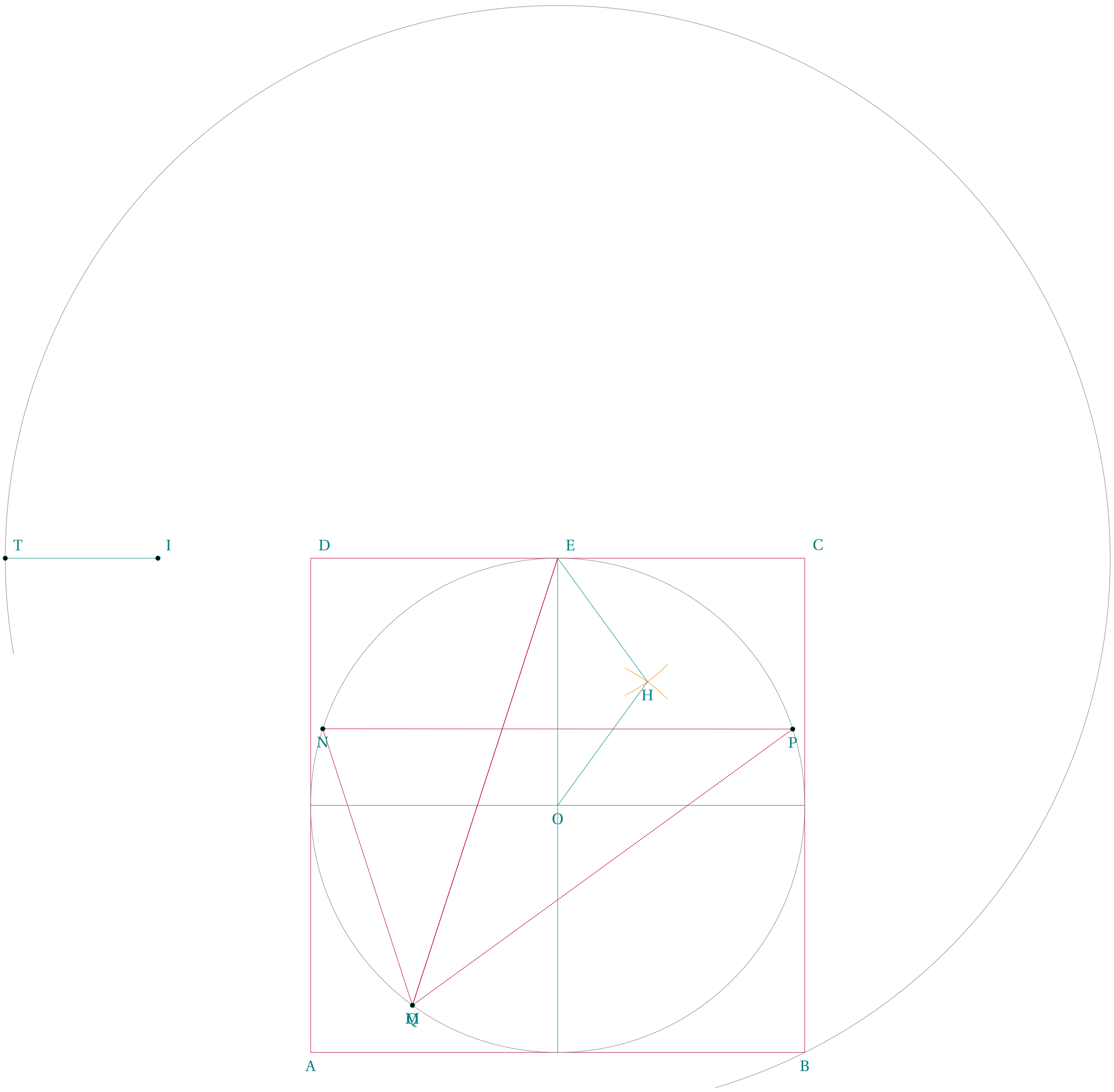



```
\begin{tikzpicture}[scale=.75]
   \tkzDefPoint(0,0){O}
   \tkzDefPoint(5,0){A}
   \tkzDefPoint(0,5){B}
   \tkzDefPoint(-5,0){C}
   \tkzDefPoint(0,-5){D}
   \tkzDefMidPoint(A,O)              \tkzGetPoint{I}
   \tkzInterLC(I,B)(I,A)             \tkzGetPoints{F}{E}
   \tkzInterCC(O,C)(B,E)             \tkzGetPoints{D3}{D2}
   \tkzInterCC(O,C)(B,F)             \tkzGetPoints{D4}{D1}
   \tkzDrawArc[angles](B,E)(180,360)
   \tkzDrawArc[angles](B,F)(220,340)
   \tkzDrawLine[add=.5 and .5](B,I)
   \tkzDrawCircle(O,A)
   \tkzDefCircle[diameter](O,A)      \tkzGetPoint{x}
   \tkzDrawCircle(x,A)
   \tkzDrawSegments(B,D C,A)
   \tkzDrawPolygon[new](D,D1,D2,D3,D4)
   \tkzDrawPoints(A,...,D,O)
   \tkzDrawPoints[new](E,F,I,D1,D2,D4,D3)
   \tkzLabelPoints[below left](A,...,D,O)
   \tkzLabelPoints[new,below right](I,E,F,D1,D2,D4,D3)
\end{tikzpicture}
```

### 47.16. Pentagon in a square

Pentagon in a square

: *To inscribe an equilateral and equiangular pentagon in a given square.*



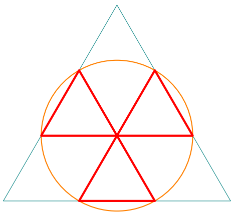
```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/O,-5/-5/A,5/-5/B}
  \tkzDefSquare(A,B)   \tkzGetPoints{C}{D}
  \tkzDefMidPoint(A,B) \tkzGetPoint{F}
  \tkzDefMidPoint(C,D) \tkzGetPoint{E}
  \tkzDefMidPoint(B,C) \tkzGetPoint{G}
  \tkzDefMidPoint(A,D) \tkzGetPoint{K}
  \tkzInterLC(D,C)(E,B)                   \tkzGetSecondPoint{T}
  \tkzDefMidPoint(D,T)                    \tkzGetPoint{I}
  \tkzInterCC[with nodes](O,D,I)(E,D,I)   \tkzGetSecondPoint{H}
  \tkzInterLC(O,H)(O,E)                   \tkzGetSecondPoint{M}
  \tkzInterCC(O,E)(E,M)                   \tkzGetFirstPoint{Q}
  \tkzInterCC[with nodes](O,O,E)(Q,E,M)   \tkzGetFirstPoint{P}
  \tkzInterCC[with nodes](O,O,E)(P,E,M)   \tkzGetFirstPoint{N}
  \tkzCompasss(O,H E,H)
  \tkzDrawArc(E,B)(T)
  \tkzDrawPolygons[purple](A,B,C,D M,E,Q,P,N)
  \tkzDrawCircle(O,E)
  \tkzDrawSegments(T,I O,H E,H E,F G,K)
  \tkzDrawPoints(T,M,Q,P,N,I)
  \tkzLabelPoints(A,B,O,N,P,Q,M,H)
  \tkzLabelPoints[above right](C,D,E,I,T)
\end{tikzpicture}
```

### 47.17. Hexagon Inscribed

**Hexagon Inscribed**

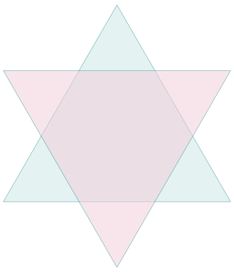
*To inscribe a regular hexagon in a given equilateral triangle perfectly inside it (no boarders).*

#### 47.17.1. Hexagon Inscribed version 1



```
\begin{tikzpicture}[scale=.5]
 \pgfmathsetmacro{\c}{6}
 \tkzDefPoints{0/0/A,\c/0/B}
 \tkzDefTriangle[equilateral](A,B)\tkzGetPoint{C}
 \tkzDefTriangleCenter[centroid](A,B,C)
 \tkzGetPoint{I}
 \tkzDefPointBy[homothety=center A ratio 1./3](B)
 \tkzGetPoint{c1}
 \tkzInterLC(B,C)(I,c1) \tkzGetPoints{a1}{a2}
 \tkzInterLC(A,C)(I,c1) \tkzGetPoints{b1}{b2}
 \tkzInterLC(A,B)(I,c1) \tkzGetPoints{c1}{c2}
 \tkzDrawPolygon(A,B,C)
 \tkzDrawCircle[thin,orange](I,c1)
 \tkzDrawPolygon[red,thick](a2,a1,b2,b1,c2,c1)
\end{tikzpicture}
```

#### 47.17.2. Hexagon Inscribed version 2

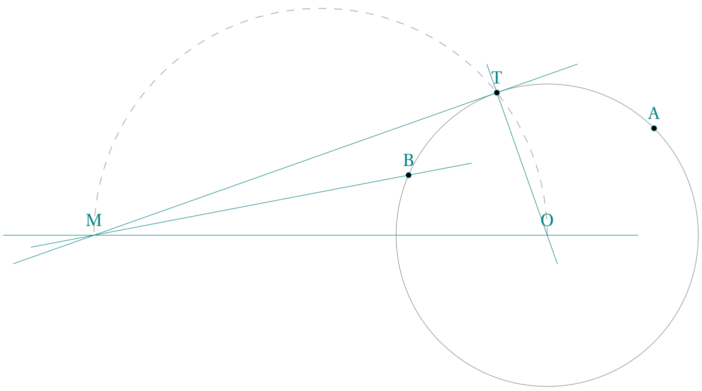


```
\begin{tikzpicture}[scale=.5]
 \pgfmathsetmacro{\c}{6}
 \tkzDefPoints{0/0/A,\c/0/B}
 \tkzDefTriangle[equilateral](A,B)\tkzGetPoint{C}
 \tkzDefTriangleCenter[centroid](A,B,C)
 \tkzGetPoint{I}
 \tkzDefPointsBy[rotation= center I%
                 angle 60](A,B,C){a,b,c}
 \tkzDrawPolygon[fill=teal!20,opacity=.5](A,B,C)
 \tkzDrawPolygon[fill=purple!20,opacity=.5](a,b,c)
\end{tikzpicture}
```

### 47.18. Power of a point with respect to a circle

**Power of a point with respect to a circle**

$\overline{MA} \times \overline{MB} = MT^2 = MO^2 - OT^2$

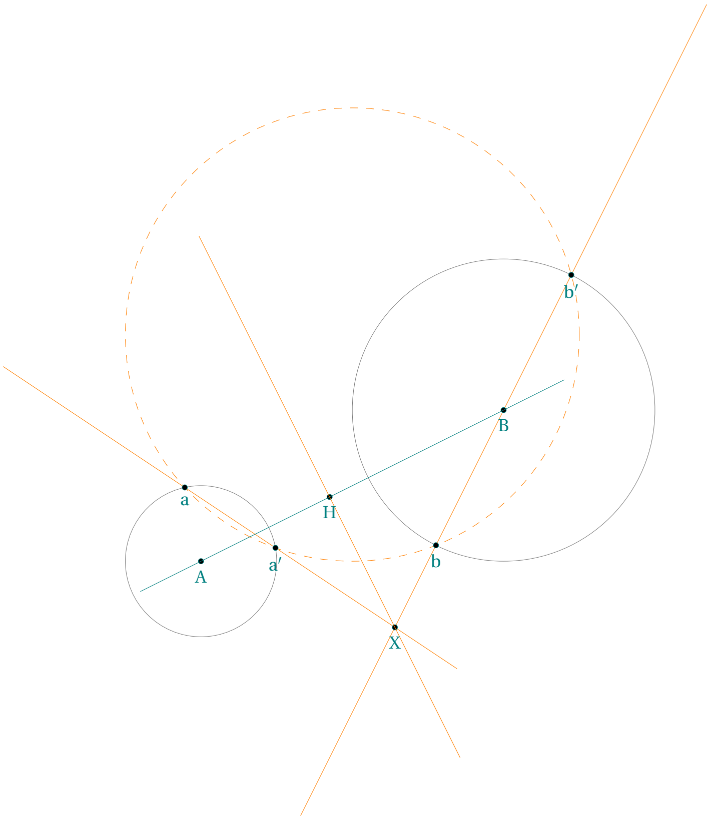



```
\begin{tikzpicture}
 \pgfmathsetmacro{\r}{2}%
 \pgfmathsetmacro{\xO}{6}%
 \pgfmathsetmacro{\xE}{\xO-\r}%
 \tkzDefPoints{0/0/M,\xO/0/O,\xE/0/E}
 \tkzDefCircle[diameter](M,O)
 \tkzGetPoint{I}
 \tkzInterCC(I,O)(O,E) \tkzGetPoints{T}{T'}
 \tkzDefShiftPoint[O](45:2){B}
 \tkzInterLC(M,B)(O,E) \tkzGetPoints{A}{B}
 \tkzDrawCircle(O,E)
 \tkzDrawSemiCircle[dashed](I,O)
 \tkzDrawLine(M,O)
 \tkzDrawLines(M,T O,T M,B)
 \tkzDrawPoints(A,B,T)
 \tkzLabelPoints[above](A,B,O,M,T)
\end{tikzpicture}
```

### 47.19. Radical axis of two non-concentric circles

**Radical axis of two non-concentric circles**

From Wikipedia : *In geometry, the radical axis of two non-concentric circles is the set of points whose power with respect to the circles are equal. For this reason the radical axis is also called the power line or power bisector of the two circles. The notation radical axis was used by the French mathematician M. Chasles as axe radical.*

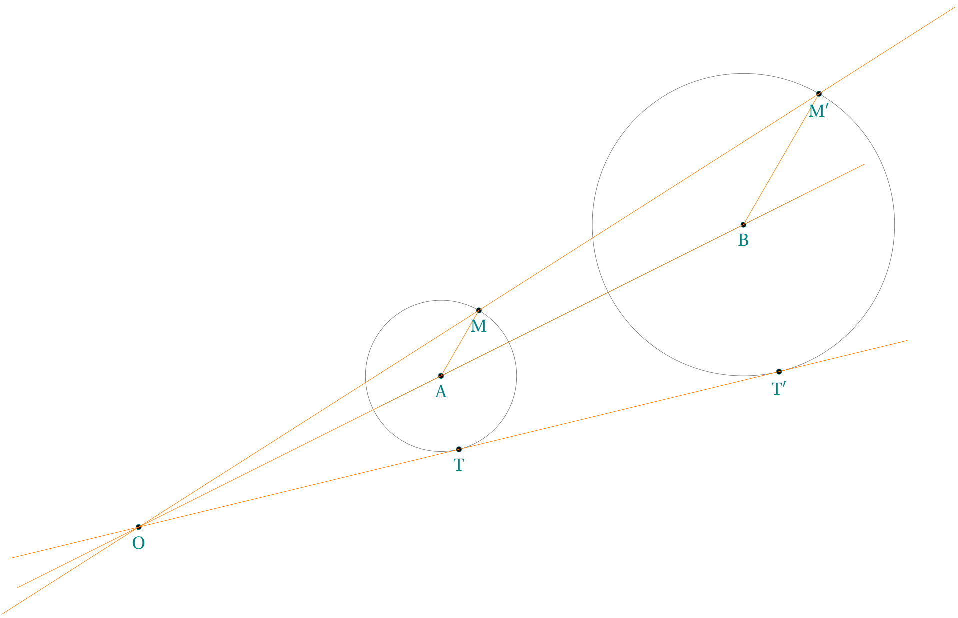



```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,4/2/B,2/3/K}
\tkzDefCircle[R](A,1)\tkzGetPoint{a}
\tkzDefCircle[R](B,2)\tkzGetPoint{b}
\tkzDefCircle[R](K,3)\tkzGetPoint{k}
\tkzDrawCircles(A,a B,b)
\tkzDrawCircle[dashed,new](K,k)
\tkzInterCC(A,a)(K,k) \tkzGetPoints{a}{a'}
\tkzInterCC(B,b)(K,k) \tkzGetPoints{b}{b'}
\tkzDrawLines[new,add=2 and 2](a,a')
\tkzDrawLines[new,add=1 and 1](b,b')
\tkzInterLL(a,a')(b,b') \tkzGetPoint{X}
\tkzDefPointBy[projection= onto A--B](X) \tkzGetPoint{H}
\tkzDrawPoints(A,B,H,X,a,b,a',b')
\tkzDrawLine(A,B)
\tkzDrawLine[add= 1 and 2,new](X,H)
\tkzLabelPoints(A,B,H,X,a,b,a',b')
\end{tikzpicture}
```

### 47.20. External homothetic center

**External homothetic center**

From Wikipedia : *Given two nonconcentric circles, draw radii parallel and in the same direction. Then the line joining the extremities of the radii passes through a fixed point on the line of centers which divides that line externally in the ratio of radii. This point is called the external homothetic center, or external center of similitude (Johnson 1929, pp. 19-20 and 41).*

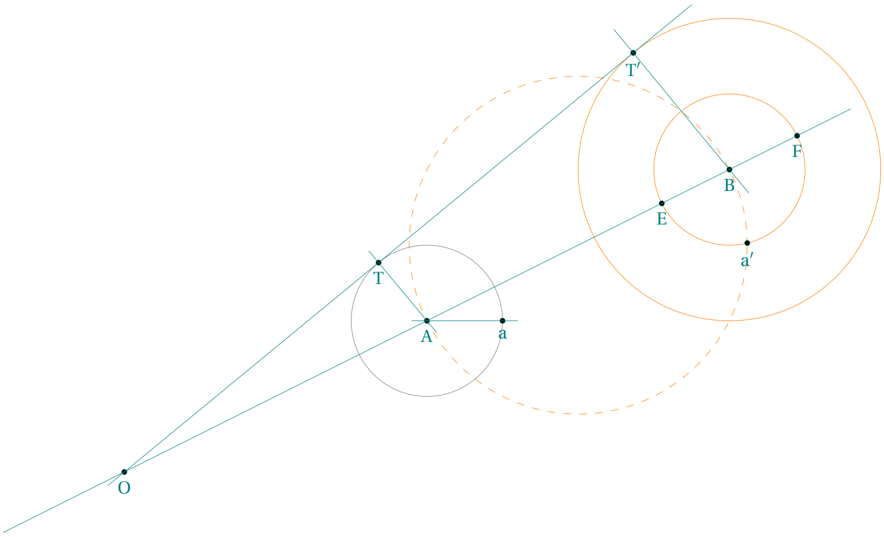



```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,4/2/B,2/3/K}
\tkzDefCircle[R](A,1)\tkzGetPoint{a}
\tkzDefCircle[R](B,2)\tkzGetPoint{b}
\tkzDrawCircles(A,a B,b)
\tkzDrawLine(A,B)
\tkzDefShiftPoint[A](60:1){M}
\tkzDefShiftPoint[B](60:2){M'}
\tkzInterLL(A,B)(M,M') \tkzGetPoint{O}
\tkzDefLine[tangent from = O](B,M') \tkzGetPoints{X}{T'}
\tkzDefLine[tangent from = O](A,M) \tkzGetPoints{X}{T}
\tkzDrawPoints(A,B,O,T,T',M,M')
\tkzDrawLines[new](O,B O,T' O,M')
\tkzDrawSegments[new](A,M B,M')
\tkzLabelPoints(A,B,O,T,T',M,M')
\end{tikzpicture}
```

## 47.21. Tangent lines to two circles

**Tangent lines to two circles**

*For two circles, there are generally four distinct lines that are tangent to both if the two circles are outside each other. For two of these, the external tangent lines, the circles fall on the same side of the line; the external tangent lines intersect in the external homothetic center*

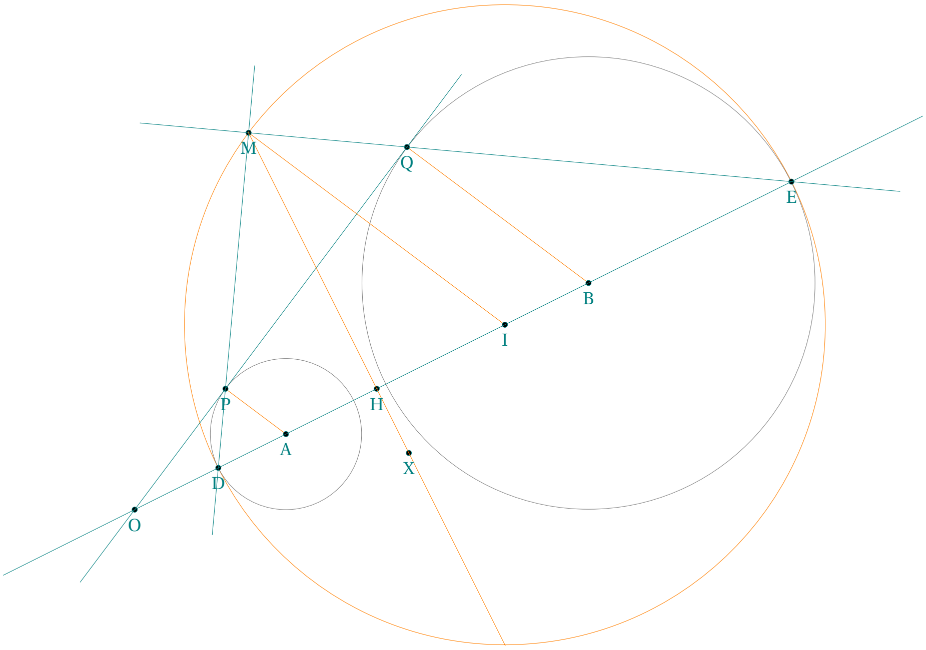



```
\begin{tikzpicture}
 \pgfmathsetmacro{\r}{1}%
 \pgfmathsetmacro{\R}{2}%
 \pgfmathsetmacro{\rt}{\R-\r}%
 \tkzDefPoints{0/0/A,4/2/B,2/3/K}
 \tkzDefMidPoint(A,B) \tkzGetPoint{I}
 \tkzInterLC[R](A,B)(B,\rt) \tkzGetPoints{E}{F}
 \tkzInterCC(I,B)(B,F) \tkzGetPoints{a}{a'}
 \tkzInterLC[R](B,a)(B,\R) \tkzGetPoints{X'}{T'}
 \tkzDefLine[tangent at=T'](B) \tkzGetPoint{h}
 \tkzInterLL(T',h)(A,B) \tkzGetPoint{O}
 \tkzInterLC[R](O,T')(A,\r) \tkzGetPoints{T}{T}
 \tkzDefCircle[R](A,\r)  \tkzGetPoint{a}
 \tkzDefCircle[R](B,\R)  \tkzGetPoint{b}
 \tkzDefCircle[R](B,\rt)  \tkzGetPoint{c}
 \tkzDrawCircles(A,a)
 \tkzDrawCircles[orange](B,b B,c)
 \tkzDrawCircle[orange,dashed](I,B)
 \tkzDrawPoints(O,A,B,a,a',E,F,T',T)
 \tkzDrawLines(O,B A,a B,T' A,T)
 \tkzDrawLines[add= 1 and 8](T',h)
 \tkzLabelPoints(O,A,B,a,a',E,F,T,T')
\end{tikzpicture}
```

### 47.22. Tangent lines to two circles with radical axis

**Tangent lines to two circles with radical axis**

*As soon as two circles are not concentric, we can construct their radical axis, the set of points of equal power with respect to the two circles. We know that the radical axis is a line orthogonal to the line of the centers. Note that if we specify* P *and* Q *as the points of contact of one of the common exterior tangents with the two circles and* D *and* E *as the points of the circles outside [AB], then (DP) and (EQ) intersect on the radical axis of the two circles. We will show that this property is always true and that it allows us to construct common tangents, even when the circles have the same radius.*

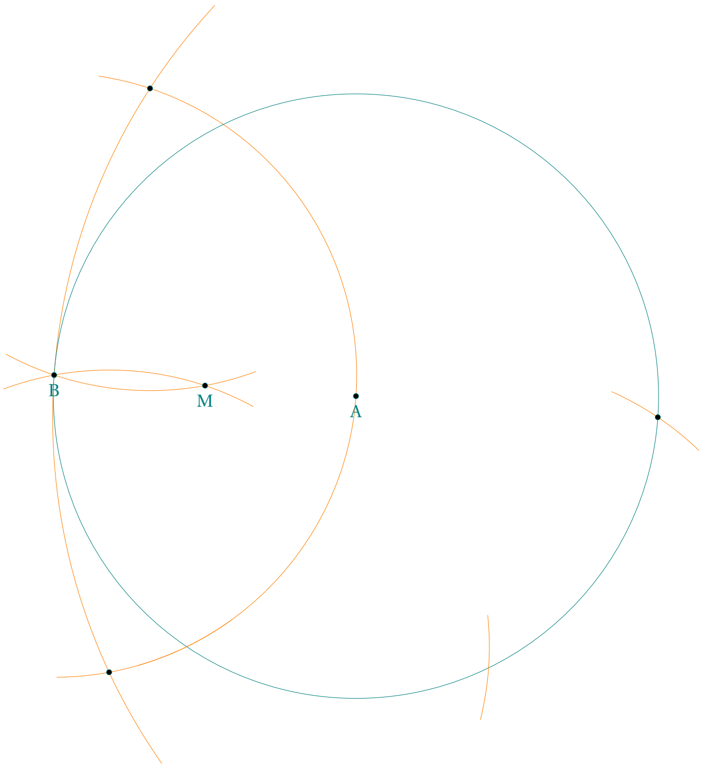


```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,4/2/B,2/3/K}
\tkzDefCircle[R](A,1) \tkzGetPoint{a}
\tkzDefCircle[R](B,3) \tkzGetPoint{b}
\tkzInterCC[R](A,1)(K,3) \tkzGetPoints{a}{a'}
\tkzInterCC[R](B,3)(K,3) \tkzGetPoints{b}{b'}
\tkzInterLL(a,a')(b,b')  \tkzGetPoint{X}
\tkzDefPointBy[projection= onto A--B](X) \tkzGetPoint{H}
\tkzGetPoint{C}
\tkzInterLC[R](A,B)(B,3) \tkzGetPoints{b1}{E}
\tkzInterLC[R](A,B)(A,1) \tkzGetPoints{D}{a2}
\tkzDefMidPoint(D,E) \tkzGetPoint{I}
\tkzDrawCircle[orange](I,D)
\tkzInterLC(X,H)(I,D) \tkzGetPoints{M}{M'}
\tkzInterLC(M,D)(A,D) \tkzGetPoints{P}{P'}
\tkzInterLC(M,E)(B,E) \tkzGetPoints{Q'}{Q}
\tkzInterLL(P,Q)(A,B) \tkzGetPoint{O}
\tkzDrawCircles(A,a B,b)
\tkzDrawSegments[orange](A,P I,M B,Q)
\tkzDrawPoints(A,B,D,E,M,I,O,P,Q,X,H)
\tkzDrawLines(O,E M,D M,E O,Q)
\tkzDrawLine[add= 3 and 4,orange](X,H)
\tkzLabelPoints(A,B,D,E,M,I,O,P,Q,X,H)
\end{tikzpicture}
```

### 47.23. Middle of a segment with a compass

**Tangent lines to two circles with radical axis**

*This example involves determining the middle of a segment, using only a compass.*



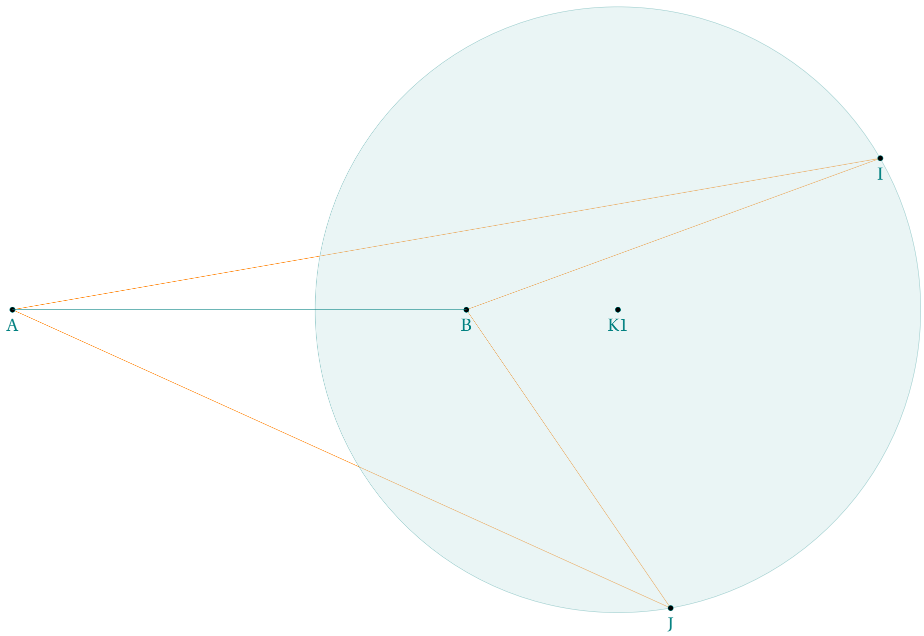

```
\begin{tikzpicture}
\tkzDefPoint(0,0){A}
\tkzDefRandPointOn[circle= center A radius 4]    \tkzGetPoint{B}
\tkzDefPointBy[rotation= center A angle 180](B)  \tkzGetPoint{C}
\tkzInterCC(A,B)(B,A)                            \tkzGetPoints{I}{I'}
\tkzInterCC(A,I)(I,A)                            \tkzGetPoints{J}{B}
\tkzInterCC(B,A)(C,B)                            \tkzGetPoints{D}{E}
\tkzInterCC(D,B)(E,B)                            \tkzGetPoints{M}{M'}
\tkzSetUpArc[color=orange,style=solid,delta=10]
\tkzDrawArc(C,D)(E)
\tkzDrawArc(B,E)(D)
\tkzDrawCircle[color=teal,line width=.2pt](A,B)
\tkzDrawArc(D,B)(M)
\tkzDrawArc(E,M)(B)
\tkzCompasss[color=orange,style=solid](B,I I,J J,C)
\tkzDrawPoints(A,B,C,D,E,M)
\tkzLabelPoints(A,B,M)
\end{tikzpicture}
```

### 47.24. Definition of a circle _Apollonius_

**Definition of a circle _Apollonius_**

From Wikipedia : *Apollonius showed that a circle can be defined as the set of points in a plane that have a specified ratio of distances to two fixed points, known as foci. This Apollonian circle is the basis of the Apollonius pursuit problem. ... The solutions to this problem are sometimes called the circles of Apollonius.*

Explanation
A circle is the set of points in a plane that are equidistant from a given point O. The distance r from the center is called the radius, and the point O is called the center. It is the simplest definition but it is not the only one. Apollonius of Perga gives another definition : The set of all points whose distances from two fixed points are in a constant ratio is a circle.
With `tkz-euclide` is easy to show you the last definition

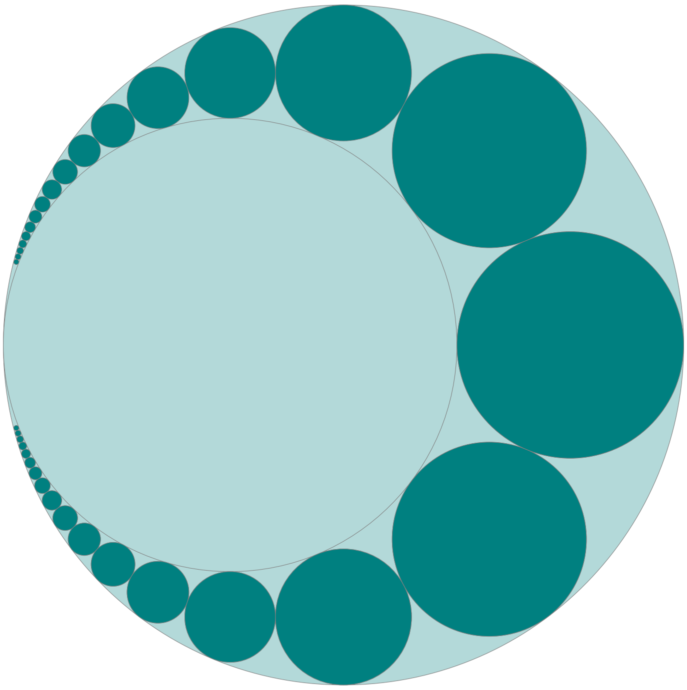



```
\begin{tikzpicture}[scale=1.5]
    % Firstly we defined two fixed point.
    % The figure depends of these points and the ratio K
\tkzDefPoint(0,0){A}
\tkzDefPoint(4,0){B}
    % tkz-euclide.sty knows about the apollonius's circle
    % with K=2 we search some points like  I such as IA=2 x IB
\tkzDefCircle[apollonius,K=2](A,B) \tkzGetPoints{K1}{k}
\tkzDefPointOnCircle[through=  center K1 angle 30 point k]
\tkzGetPoint{I}
\tkzDefPointOnCircle[through= center K1 angle 280  point k]
\tkzGetPoint{J}
\tkzDrawSegments[new](A,I I,B A,J J,B)
\tkzDrawCircle[color = teal,fill=teal!20,opacity=.4](K1,k)
\tkzDrawPoints(A,B,K1,I,J)
\tkzDrawSegment(A,B)
\tkzLabelPoints[below,font=\scriptsize](A,B,K1,I,J)
\end{tikzpicture}
```

### 47.25. Application of Inversion : Pappus chain

**Pappus chain**

From Wikipedia *In geometry, the Pappus chain is a ring of circles between two tangent circles investigated by Pappus of Alexandria in the 3rd century AD.*

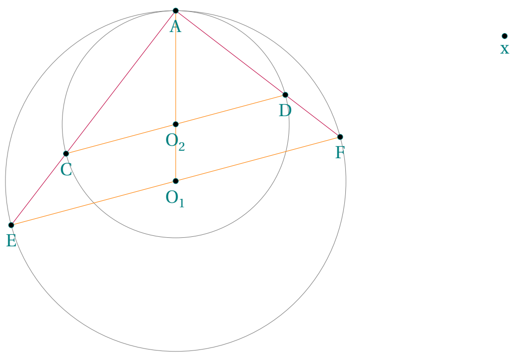


```
\begin{tikzpicture}[ultra thin]
  \pgfmathsetmacro{\xB}{6}%
  \pgfmathsetmacro{\xC}{9}%
  \pgfmathsetmacro{\xD}{(\xC*\xC)/\xB}%
  \pgfmathsetmacro{\xJ}{(\xC+\xD)/2}%
  \pgfmathsetmacro{\r}{\xD-\xJ}%
  \pgfmathsetmacro{\nc}{16}%
  \tkzDefPoints{0/0/A,\xB/0/B,\xC/0/C,\xD/0/D}
  \tkzDefCircle[diameter](A,C) \tkzGetPoint{x}
  \tkzDrawCircle[fill=teal!30](x,C)
  \tkzDefCircle[diameter](A,B) \tkzGetPoint{y}
  \tkzDrawCircle[fill=teal!30](y,B)
  \foreach \i in {-\nc,...,0,...,\nc}
  {\tkzDefPoint(\xJ,2*\r*\i){J}
   \tkzDefPoint(\xJ,2*\r*\i-\r){H}
   \tkzDefCircleBy[inversion = center A through C](J,H)
   \tkzDrawCircle[fill=teal](tkzFirstPointResult,tkzSecondPointResult)}
\end{tikzpicture}
```

### 47.26. Book of lemmas proposition 1 Archimedes

**Book of lemmas proposition 1 Archimedes**

*If two circles touch at* A*, and if* [CD], [EF] *be parallel diameters in them,* A, C *and* E *are aligned.*




```
\begin{tikzpicture}[scale=.75]
  \tkzDefPoints{0/0/O_1,0/1/O_2,0/3/A}
  \tkzDefPoint(15:3){F}
   \tkzDefPointBy[symmetry=center O_1](F) \tkzGetPoint{E}
   \tkzDefLine[parallel=through O_2](E,F) \tkzGetPoint{x}
   \tkzInterLC(x,O_2)(O_2,A) \tkzGetPoints{D}{C}
   \tkzDrawCircles(O_1,A O_2,A)
   \tkzDrawSegments[orange](O_1,A E,F C,D)
   \tkzDrawSegments[purple](A,E A,F)
   \tkzDrawPoints(A,O_1,O_2,E,F,x,C,D)
   \tkzLabelPoints(A,O_1,O_2,E,F,x,C,D)
\end{tikzpicture}
```

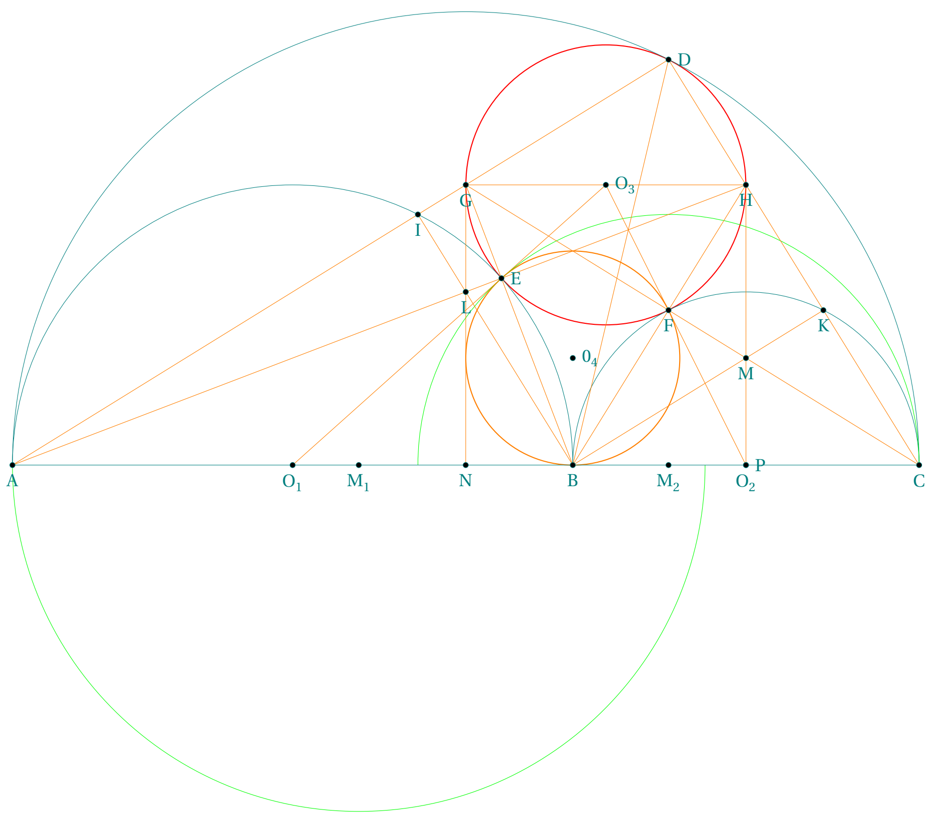
(CD) ∥ (EF) $(AO_1)$ is secant to these two lines so $\widehat{A0_2C} = \widehat{A0_1E}$.
Since the triangles $AO_2C$ and $AO_1E$ are isosceles the angles at the base are equal widehat$AC0_2 = \widehat{AE0_1} = \widehat{CA0_2} = \widehat{EA0_1}$. Thus A,C and E are aligned

### 47.27. Book of lemmas proposition 6 Archimedes

**Book of lemmas proposition 6 Archimedes**

*Let* AC*, the diameter of a semicircle, be divided at* B *so that* AC/AB = $\phi$ *or in any ratio. Describe semicircles within the first semicircle and on* AB, BC *as diameters, and suppose a circle drawn touching the all three semicircles. If* GH *be the diameter of this circle, to find relation between* GH *and* AC.

```
\begin{tikzpicture}
\tkzDefPoints{0/0/A,12/0/C}
\tkzDefGoldenRatio(A,C)                     \tkzGetPoint{B}
\tkzDefMidPoint(A,C)                        \tkzGetPoint{O}
\tkzDefMidPoint(A,B)                        \tkzGetPoint{O_1}
\tkzDefMidPoint(B,C)                        \tkzGetPoint{O_2}
\tkzDefExtSimilitudeCenter(O_1,A)(O_2,B) \tkzGetPoint{M_0}
\tkzDefIntSimilitudeCenter(O,A)(O_1,A)      \tkzGetPoint{M_1}
\tkzDefIntSimilitudeCenter(O,C)(O_2,C)      \tkzGetPoint{M_2}
\tkzInterCC(O_1,A)(M_2,C)                   \tkzGetFirstPoint{E}
\tkzInterCC(O_2,C)(M_1,A)                   \tkzGetSecondPoint{F}
\tkzInterCC(O,A)(M_0,B)                     \tkzGetFirstPoint{D}
\tkzInterLL(O_1,E)(O_2,F)                   \tkzGetPoint{O_3}
\tkzDefCircle[circum](E,F,B)                \tkzGetPoint{0_4}
\tkzInterLC(A,D)(O_1,A)                     \tkzGetFirstPoint{I}
\tkzInterLC(C,D)(O_2,B)                     \tkzGetSecondPoint{K}
\tkzInterLC[common=D](A,D)(O_3,D)           \tkzGetFirstPoint{G}
\tkzInterLC[common=D](C,D)(O_3,D)           \tkzGetFirstPoint{H}
\tkzInterLL(C,G)(B,K)                       \tkzGetPoint{M}
\tkzInterLL(A,H)(B,I)                       \tkzGetPoint{L}
\tkzInterLL(L,G)(A,C)                       \tkzGetPoint{N}
\tkzInterLL(M,H)(A,C)                       \tkzGetPoint{P}
\tkzDrawCircles[red,thin](O_3,F)
\tkzDrawCircles[new,thin](0_4,B)
\tkzDrawSemiCircles[teal](O,C O_1,B O_2,C)
\tkzDrawSemiCircles[green](M_2,C)
\tkzDrawSemiCircles[green,swap](M_1,A)
\tkzDrawSegment(A,C)
\tkzDrawSegments[new](O_1,O_3 O_2,O_3)
\tkzDrawSegments[new,very thin](B,H C,G A,H G,N H,P)
\tkzDrawSegments[new,very thin](B,D A,D C,D G,H I,B K,B B,G)
\tkzDrawPoints(A,B,C,M_1,M_2,E,O_3,F,D,0_4,O_1,O_2,I,K,G,H,L,P,N,M)
\tkzLabelPoints[font=\scriptsize](A,B,C,M_1,M_2,F,O_1,O_2,I,K,G,H,L,M,N)
\tkzLabelPoints[font=\scriptsize,right](E,O_3,D,0_4,P)
\end{tikzpicture}
```




Let GH be the diameter of the circle which is parallel to AC, and let the circle touch the semicircles on AC, AB, BC in D, E, F respectively.
Then, by Prop. 1 A,G and D are aligned, ainsi que D, H and C.
For a like reason A E and H are aligned, C F and Gare aligned, as also are B E and G, B F and H.
Let (AD) meet the semicircle on [AC] at I, and let (BD) meet the semicircle on [BC] in K. Join CI, CK meeting AE, BF in L, M, and let GL, HM produced meet AB in N, P respectively.
Now, in the triangle AGB, the perpendiculars from A, C on the opposite sides meet in L. Therefore by the properties of triangles, (GN) is perpendicular to (AC). Similarly (HP) is perpendicular to (BC).
Again, since the angles at I, K, D are right, (CK) is parallel to (AD), and (CI) to (BD).
Therefore

$$\frac{AB}{BC} = \frac{AL}{LH} = \frac{AN}{NP} \quad \text{and} \quad \frac{BC}{AB} = \frac{CM}{MG} = \frac{PC}{NP}$$

hence

$$\frac{AN}{NP} = \frac{NP}{PC} \quad \text{so} \quad NP^2 = AN \times PC$$

Now suppose that B divides [AC] according to the divine proportion that is :

$$\phi = \frac{AB}{BC} = \frac{AC}{AB} \quad \text{then} \quad AN = \phi NP \text{and} \quad NP = \phi PC$$

We have

$$AC = AN + NP + PC \quad \text{either} \quad AB + BC == AN + NP + PC \quad \text{or} \quad (\phi+1)BC = AN + NP + PC$$

we get

$$(\phi+1)BC = \phi NP + NP + PC = (\phi+1)NP + PC = \phi(\phi+1)PC + PC = \phi^2 + \phi + 1)PC$$

as

$$\phi^2 = \phi + 1 \quad \text{then} \quad (\phi + 1)\mathrm{BC} = 2(\phi + 1)\mathrm{PC} \quad \text{i.e.} \quad \mathrm{BC} = 2\mathrm{PC}$$

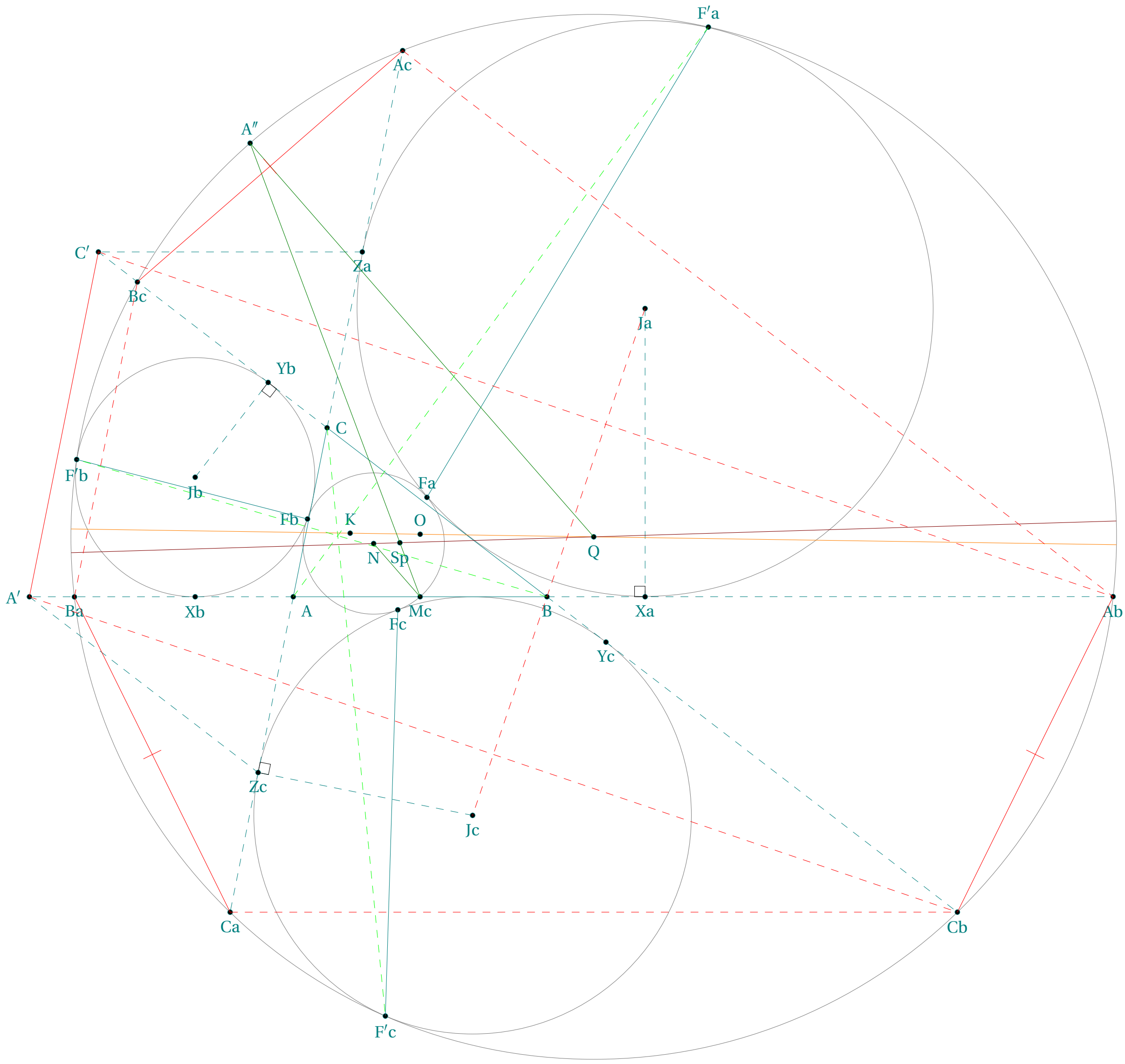
That is, p is the middle of the segment BC.
Part of the proof from `https://www.cut-the-knot.org`

### 47.28. "The" Circle of APOLLONIUS

**The Apollonius circle of a triangle _Apollonius_**

*The circle which touches all three excircles of a triangle and encompasses them is often known as "the" Apollonius circle (Kimberling 1998, p. 102)*

Explanation
The purpose of the first examples was to show the simplicity with which we could recreate these propositions. With TikZ you need to do calculations and use trigonometry while with `tkz-euclide` you only need to build simple objects
But don't forget that behind or far above `tkz-euclide` there is TikZ. I'm only creating an interface between TikZ and the user of my package.
The last example is very complex and it is to show you all that we can do with `tkz-euclide`.


F′a
Ac
A″
C′
Za
Bc
Ja
Yb
C
F′b
Jb
Fa
Fb
K
O
N
Sp
Q
A′
Ba
Xb
A
Mc
Fc
B
Xa
Ab
Yc
Zc
Jc
Ca
Cb
F′c

```
\begin{tikzpicture}[scale=.6]
\tkzDefPoints{0/0/A,6/0/B,0.8/4/C}
\tkzDefTriangleCenter[euler](A,B,C)       \tkzGetPoint{N}
\tkzDefTriangleCenter[circum](A,B,C)      \tkzGetPoint{O}
\tkzDefTriangleCenter[lemoine](A,B,C)     \tkzGetPoint{K}
\tkzDefTriangleCenter[ortho](A,B,C)       \tkzGetPoint{H}
\tkzDefSpcTriangle[excentral,name=J](A,B,C){a,b,c}
\tkzDefSpcTriangle[centroid,name=M](A,B,C){a,b,c}
\tkzDefCircle[in](Ma,Mb,Mc)               \tkzGetPoint{Sp}  % Sp Spieker center
\tkzDefProjExcenter[name=J](A,B,C)(a,b,c){Y,Z,X}
\tkzDefLine[parallel=through Za](A,B)     \tkzGetPoint{Xc}
\tkzInterLL(Za,Xc)(C,B)                   \tkzGetPoint{C'}
\tkzDefLine[parallel=through Zc](B,C)     \tkzGetPoint{Ya}
\tkzInterLL(Zc,Ya)(A,B)                   \tkzGetPoint{A'}
\tkzDefPointBy[reflection= over Ja--Jc](C')\tkzGetPoint{Ab}
\tkzDefPointBy[reflection= over Ja--Jc](A')\tkzGetPoint{Cb}
\tkzInterLL(K,O)(N,Sp)                    \tkzGetPoint{Q}
\tkzInterLC(A,B)(Q,Cb)                    \tkzGetFirstPoint{Ba}
\tkzInterLC(A,C)(Q,Cb)                    \tkzGetPoints{Ac}{Ca}
\tkzInterLC(B,C')(Q,Cb)                   \tkzGetFirstPoint{Bc}
\tkzInterLC[next to=Ja](Ja,Q)(Q,Cb)       \tkzGetFirstPoint{F'a}
\tkzInterLC[next to=Jc](Jc,Q)(Q,Cb)       \tkzGetFirstPoint{F'c}
\tkzInterLC[next to=Jb](Jb,Q)(Q,Cb)       \tkzGetFirstPoint{F'b}
\tkzInterLC[common=F'a](Sp,F'a)(Ja,F'a)   \tkzGetFirstPoint{Fa}
\tkzInterLC[common=F'b](Sp,F'b)(Jb,F'b)   \tkzGetFirstPoint{Fb}
\tkzInterLC[common=F'c](Sp,F'c)(Jc,F'c)   \tkzGetFirstPoint{Fc}
\tkzInterLC(Mc,Sp)(Q,Cb)                  \tkzGetFirstPoint{A''}
\tkzDefCircle[euler](A,B,C)               \tkzGetPoints{E}{e}
\tkzDefCircle[ex](C,A,B)                  \tkzGetPoints{Ea}{a}
\tkzDefCircle[ex](A,B,C)                  \tkzGetPoints{Eb}{b}
\tkzDefCircle[ex](B,C,A)                  \tkzGetPoints{Ec}{c}
% Calculations are done, now you can draw, mark and label
\tkzDrawCircles(Q,Cb E,e)%
\tkzDrawCircles(Eb,b Ea,a Ec,c)
\tkzDrawPolygon(A,B,C)
\tkzDrawSegments[dashed](A,A' C,C' A',Zc Za,C' B,Cb B,Ab A,Ca)
\tkzDrawSegments[dashed](C,Ac Ja,Xa Jb,Yb Jc,Zc)
\begin{scope}
   \tkzClipCircle(Q,Cb) % We limit the drawing of the lines
   \tkzDrawLine[add=5 and 12,orange](K,O)
   \tkzDrawLine[add=12 and 28,red!50!black](N,Sp)
\end{scope}
\tkzDrawPoints(A,B,C,K,Ja,Jb,Jc,Q,N,O,Sp,Mc,Xa,Xb,Yb,Yc,Za,Zc)
\tkzDrawPoints(A',C',A'',Ab,Cb,Bc,Ca,Ac,Ba,Fa,Fb,Fc,F'a,F'b,F'c)
\tkzLabelPoints(Ja,Jb,Jc,Q,Xa,Xb,Za,Zc,Ab,Cb,Bc,Ca,Ac,Ba,F'b)
\tkzLabelPoints[above](O,K,F'a,Fa,A'')
\tkzLabelPoints[below](B,F'c,Yc,N,Sp,Fc,Mc)
\tkzLabelPoints[left](A',C',Fb)
\tkzLabelPoints[right](C)
\tkzLabelPoints[below right](A)
\tkzLabelPoints[above right](Yb)
\tkzDrawSegments(Fc,F'c Fb,F'b Fa,F'a)
\tkzDrawSegments[color=green!50!black](Mc,N Mc,A'' A'',Q)
\tkzDrawSegments[color=red,dashed](Ac,Ab Ca,Cb Ba,Bc Ja,Jc A',Cb C',Ab)
\tkzDrawSegments[color=red](Cb,Ab Bc,Ac Ba,Ca A',C')
\tkzMarkSegments[color=red,mark=|](Cb,Ab Bc,Ac Ba,Ca)
\tkzMarkRightAngles(Jc,Zc,A Ja,Xa,B Jb,Yb,C)
\tkzDrawSegments[green,dashed](A,F'a B,F'b C,F'c)
\end{tikzpicture}
```

# Part X.

# FAQ

# 48. FAQ

## 48.1. Most common errors

For the moment, I'm basing myself on my own, because having changed syntax several times, I've made a number of mistakes. This section is going to be expanded. With version 4.05 new problems may appear.

- The mistake I make most often is to forget to put an "s" in the macro used to draw more than one object: like `\tkzDrawSegment(s)` or `\tkzDrawCircle(s)` ok like in this example `\tkzDrawPoint(A,B)` when you need `\tkzDrawPoints(A,B)`;

- Don't forget that since version 4 the unit is obligatorily the "cm" it is thus necessary to withdraw the unit like here `\tkzDrawCircle[R](O,3cm)` which becomes `\tkzDrawCircle[R](O,3)`. The traditional options of `TikZ` keep their units example`below right = 12pt` on the other hand one will write `size=1.2` to position an arc in `\tkzMarkAngle`;

- The following error still happens to me from time to time. A point that is created has its name in brackets while a point that is used either as an option or as a parameter has its name in braces.

  Example `\tkzGetPoint(A)` When defining an object, use braces and not brackets, so write: `\tkzGetPoint{A}`;

- The changes in obtaining the points of intersection between lines and circles sometimes exchange the solutions, this leads either to a bad figure or to an error.

- `\tkzGetPoint{A}` in place of `\tkzGetFirstPoint{A}`. When a macro gives two points as results, either we retrieve these points using `\tkzGetPoints{A}{B}`, or we retrieve only one of the two points, using `\tkzGetFirstPoint{A}` or `\tkzGetSecondPoint{A}`. These two points can be used with the reference `tkzFirstPointResult` or `tkzSecondPointResult`. It is possible that a third point is given as `tkzPointResult`;

- Mixing options and arguments; all macros that use a circle need to know the radius of the circle. If the radius is given by a measure then the option includes a `R`.

- The angles are given in degrees, more rarely in radians.

- If an error occurs in a calculation when passing parameters, then it is better to make these calculations before calling the macro.

- Do not mix the syntax of `pgfmath` and `xfp`. I've often chosen `xfp` but if you prefer pgfmath then do your calculations before passing parameters.

- Error "dimension too large" : In some cases, this error occurs. One way to avoid it is to use the "`veclen`" option. When this option is used in an scope, the "veclen" function is replaced by a function dependent on "xfp". Do not use intersection macros in this scope. For example, an error occurs if you use the macro `\tkzDrawArc` with too small an angle. The error is produced by the `decoration` library when you want to place a mark on an arc. Even if the mark is absent, the error is still present.

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