

ScienceWord and PagePlayer Basic notions
on drawings and dynamic constructions

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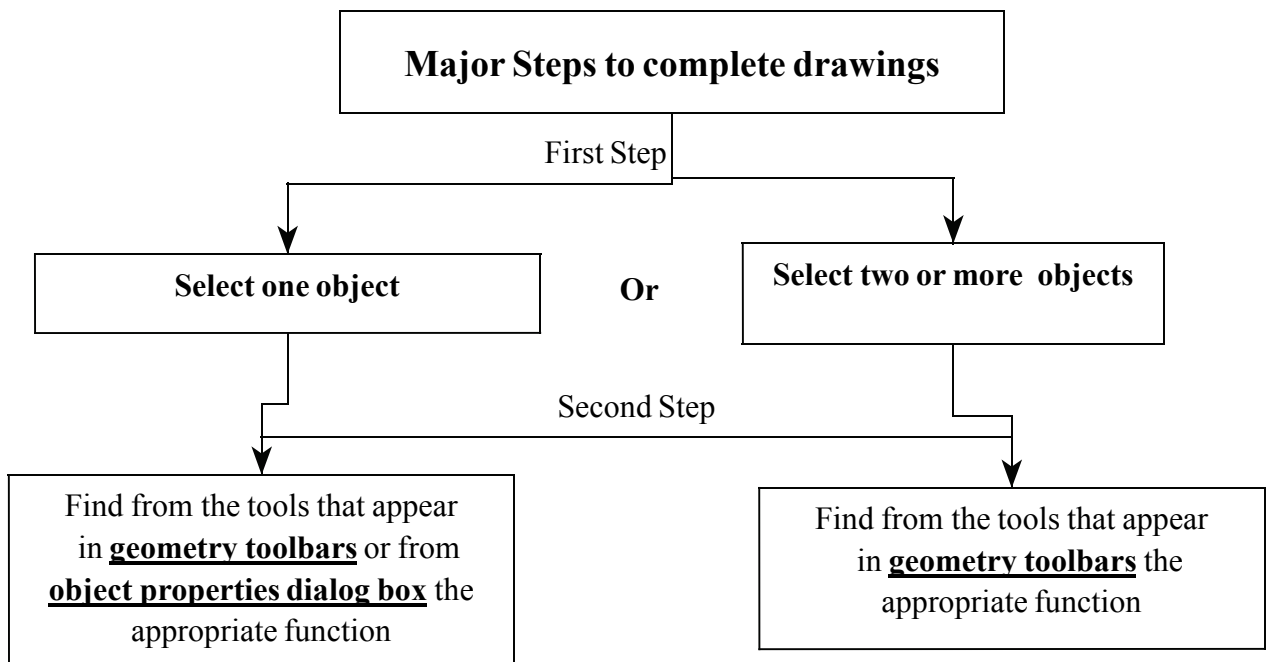
Introduction

Like in any traditional application, you can draw in ScienceWord or PagePlayer by proceeding through alignment, superposition or grouping of objects. But this is a method whose efficiency is believed to be limited. ScienceWord and PagePlayer make it also possible to draw on the basis of plane basic elements (point, line, triangle, circle, etc.), plane geometric applications (rotation, symmetric, projection, translation, homothetic) and drawing practical tools that appear in the Geometry Toolbar when one or several basic elements are selected. The additional option of drawing lines in the natural way even in continuous mode for the purpose of parallelism, perpendicularity or linking objects through a specific relationship makes geometrical drawing easier. The options in "objects Properties" and "motions properties" contribute also in a no small way in the making of drawings. Finally the animation concept based on variable objects and variable data widens the applications of ScienceWord and PagePlayer to be powerful education teaching and investigation tools at educational levels.

1) A big revolution in drawing process

a) The General process

All kinds of drawings follow not more than two major steps and all the needed functions to complete a drawing are available at not more than two locations (Geometry toolbar and Object properties dialog box)



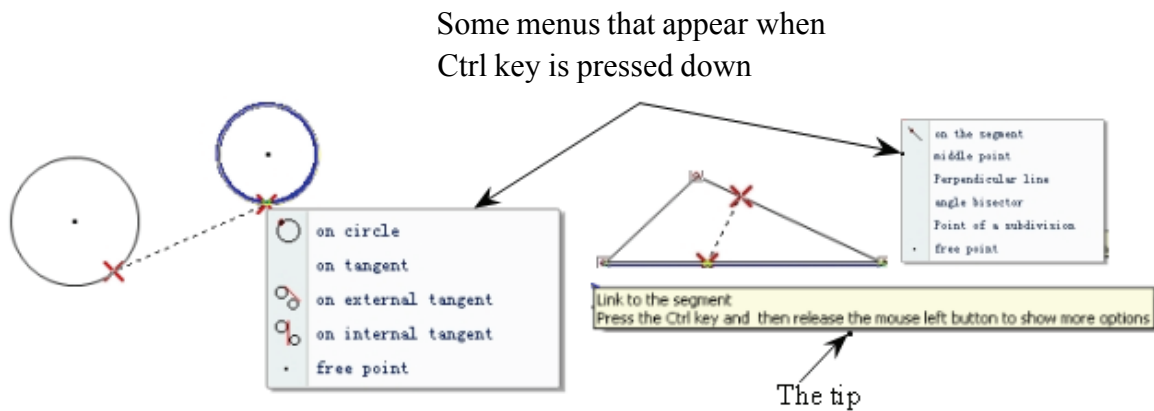
When any basic plane geometric object is drawn (but under selection) , some useful tools pop up automatically in geometry toolbar.

For example, when a point of a plane is selected, the tools for drawing a half-line coming from this point or a circle centered on this point pop up in the drawing toolbar . Similarly, when two points of the plane are selected, the tools appear in the drawing toolbar for the purpose of: drawing the segment linking these two points, subdividing this segment into a number of equal parts, determining the symmetry of one of the points in relation to the other, determining the rotation of one point around the other, drawing the circle centered on one of the points and passing through the other, or defining a vector defined by a couple of these points. **There is generally a perfect correspondence between the basic geometric drawings under consideration and the geometric tools required for creating a geometrical object.**

b) An additional option for drawing lines, circles and points

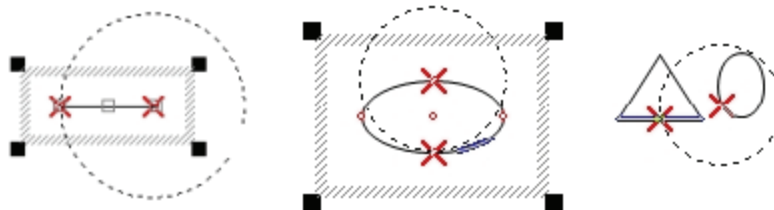
i) The natural way to draw a line

When you draw a line to an object or from this object, a tip appears automatically showing the current action and a prompt screen tells you that you could press Ctrl key and release the mouse to access more options ..



ii) The natural way to draw a circle

You can draw directly a circle centered to a point of an object or passing a point of this object directly. as shown below,



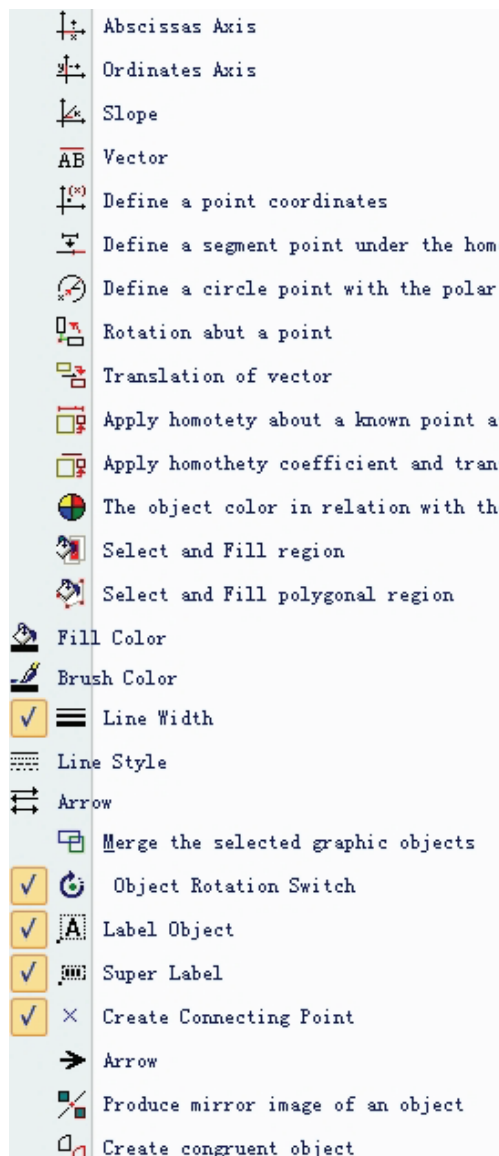
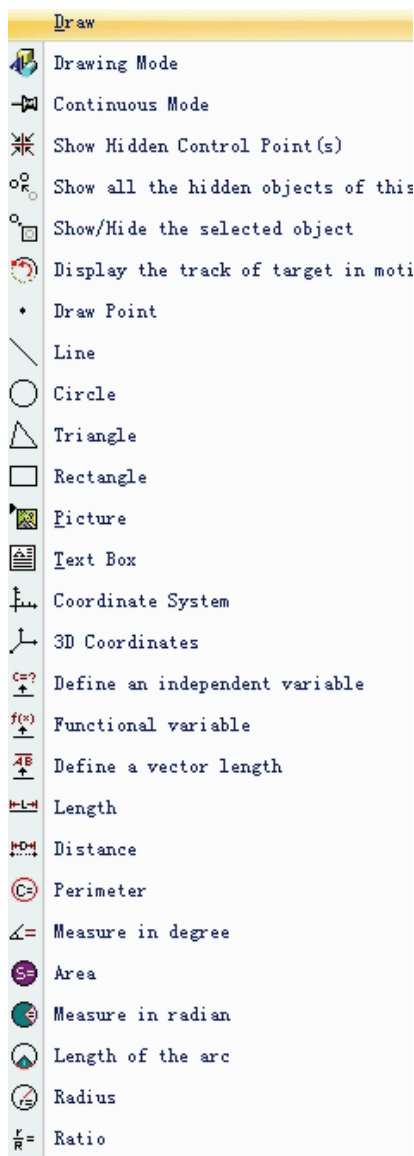
iii) The natural way to draw a point

You can draw directly a point on a segment, a polygon, a circle, an arc, an ellipse or an intersection point of a segment and a circle or two circles. Here, understand that a term "point of a line" or "point of a curve" has the meaning that the point can be displaced along the line or the curve. The same for a point of a polygon.

c) The complete list of tools that appear in Geometry toolbar

We are showing as follows the complete list of tools that appear in geometry toolbar

As it is said above, these tools appear only when the selection of geometry objects have been made



	Create similar object		Draw circle centered at one point passing through another point
	Create 3D Graphs		Select point on a circle
	Create coordinates system point		Draw radius of circle
	Draw straight line		Draw Chord of Circle
	Graph trigonometric function		Draw diameter of circle
	Graph Second Order Function		Tangent to a circle passing a known external point
	Graph exponential or logarithmic function		Tangent to a circle passing a point of the circle
	Graph Function in coordinates system		Draw line tangent to two circles, circle 1
	Polar curve		Draw line tangent to two circles, circle 2
	Graph Parametric Function		Draw circle tangent to and outside of two circles
	Multi parameters function		Draw circle tangent to and inside of two circles
	Create broken line with given Data		Draw circumscribed circle of a triangle
	Line Segment Connecting Two Known Points		Draw inscribed circle of triangle
	Draw ray passing a known point		Draw mid-line of triangle
	Select a point of a line		Draw angle bisector of triangle
	Draw bisecting point of line segment		Draw altitude of triangle
	Evenly Divide the Line		Draw line segment bisecting two sides of triangle
	Find intersection point of two lines		Draw congruent triangle
	Draw Extension of Straight Line		Draw similar triangle
	Perpendicular line passing a point		Draw circumscribed circle of regular polygon
	Angle Label Arc		Draw Inscribed Circle of Regular Polygon
	Parallel line passing a point		Intersection of two curves
	Seek intersection of line and circle		Spring
	Seek intersection of two circles		Spring
	Arc Passing Three Known Points		Spring
	Draw circle centered at a known point		Align vertical centers
	Draw ellipse passing two points		Lateral uniformly distributed
	Left aligned object group		Vertical uniform distribution
	Right Aligned object group		Play Stroke Flash
	Align horizontal centers		Select a point of a polygon
	Top aligned object group		
	Bottom aligned object group		


d) Manipulation of the tools that appear in geometry toolbar


i) The principle of manipulation



- Firstly, place the pointer on the tool momentarily to make the function it executes appear

- Secondly, click on the tool.



* Either a result is obtained immediately; this is the case for example with the inscribed circle of a triangle.


* Or a dialog box appears and you simply type simple text; this is the case for example in "Label Object" ().

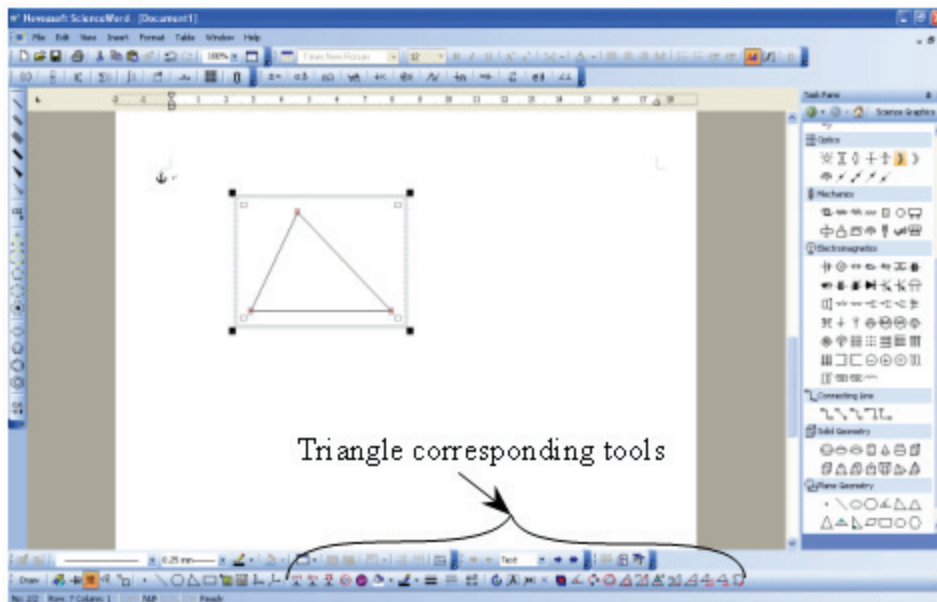
* Or text zone appears and where you can a text including formulae. this is the case for example in "Super Label"  "

* Or the pointer takes a particular shape: the shape , when clicking directly onto the workspace; the shape  when clicking at a precise place, for example on the vertex of a triangle (to draw a median line, to create an arc of a circle) or at a point of a straight line in order to select this point, etc.

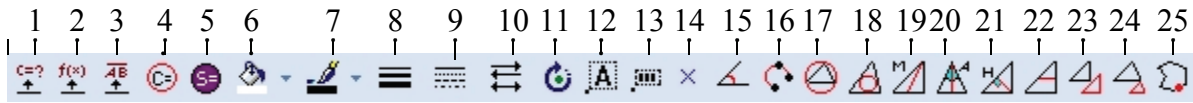
ii) Example of geometric corresponding tools of the triangle

For example, to draw a triangle in ScienceWord, click once on the "" button in the geometry toolbar, then slide the pointer to the workspace. When the pointer changes to a cross , click on your workspace to get the triangle. It appears in a rectangular region called the " Selection Region" which has a tiny white square at every corner: this is the "Selection Mode" (see the figure below) . After selecting it , you can shift it using the directional keys (\rightarrow , \leftarrow , \uparrow , \downarrow) . You could also move it with the mouse whilst it is selected. Practically, move the pointer towards the triangle and when it takes the form

 make a left-click and slide the mouse to get the shift desired..



In fact, as soon as the triangle appears, the tools also appear in the geometry toolbar.

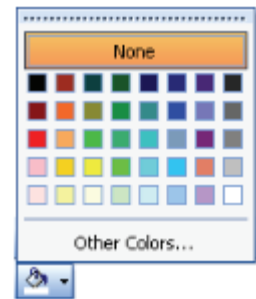
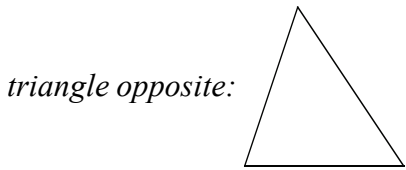



The tasks assigned to these tools are listed as follows in increasing numerical sequence:


1 - Define an independent variable; 2 - Functional variable; 3 - Define a vector length; 4 - Perimeter; 5 - Area; 6 - Fill Color; 7- Brush Color; 8 - Line Width; 9 - Line Style; 10 - Arrow; 11 - Object Rotation Switch; 12 - Label Object; 13 - Super Label; 14-Create Connecting Point; 15 - Angle Label Arc; 16- Arc passing three known points; 17- Draw circumscribed circle of triangle; 18- Draw inscribed circle of triangle; 19 - Draw median of triangle; 20 - Draw angle bisector of triangle; 21 - Draw altitude of triangle; 22- Draw line segment bisecting two sides of triangle; 23 - Draw congruent triangle; 24 - Draw similar triangle; 25 - Select a point of a polygon.

Note: When you click outside the triangle, the tools beneath would disappear. This indicates simply the fact that the triangle is no more selected. To select again the triangle, move the pointer to one of its sides, then click on this side when the pointer changes to mouse shape.

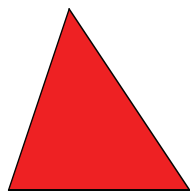
In the following, we shall be seeing the effect of each of the mentioned above tools (the five first will be study further) . In each case here, the tool shall be applied on the




"Fill Color () "

To colour the inside of the triangle, click on the  button. The following palette of colours pops up; Click for example on the red colour.


The inside of the triangle would get coloured red as in the following figure.





"Brush Color () "

To colour the sides of the triangle, click on the  button. To select a colour, click on the corresponding drop down arrow and the same palette of colours pops up as previously. For example, by clicking the colour blue, you would get the following figure;


Similarly, you could define the sides of the triangle with;

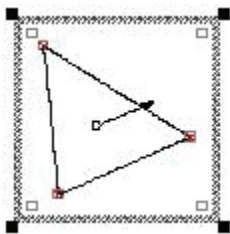
"Line Width" (), for getting the desired thickness of the line.

"Line Style" (), for getting the desired style of the line.


"Arrow" (), for putting the arrowheads desired on the ends of the line, i. e. sides of the triangle.

"Object Rotation Switch () "


To make the triangle undergo a rotation, click on the  button



You would obtain the figure:

Move the pointer to the arrowhead of the arrow that appears by default (automatically) at the center of gravity of the triangle. When the pointer takes the following shape  , hold down the left button of the mouse and then move the mouse in the direction you wish, in order to effect slight movements of the triangle and then get the desired rotation. To move the center of rotation to a given point, just move the arrow so as to place its origin at the chosen point which then becomes the new center of rotation.

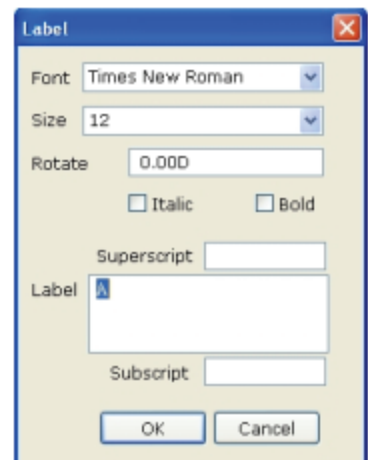
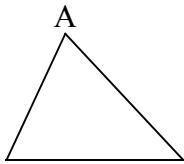
"Label Object" ()

ScienceWord makes possible label objects by using the **"Label Object"** function (). We are for example going to label the top point of the triangle (let's label it "A" for example).


To do this, select the triangle and then click on the  button in the geometry toolbar. The opposite dialog box appears:

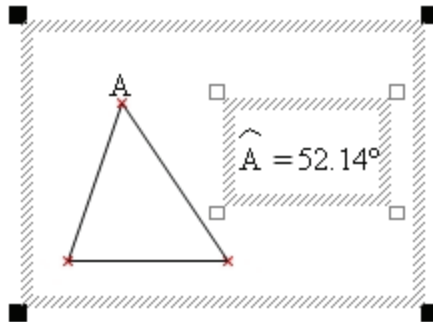
You could for example select the size 12 by clicking on the drop down arrow of the "size" field. Confirm your choice by clicking on "OK".

You could get the following figure by adjusting the position of "A" with the arrow keys. Actually, the letter "A" appears as an image.




"**Super Label Object**"

ScienceWord makes possible label objects by using the "**Super Label Object**" function  where it is possible to write text with several lines, symbols, formulae of all kinds and even insert pictures exactly like in Text Box! (See picture below).





"**Connecting Point**" ()"

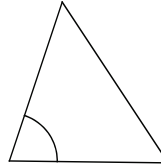
You could also create an interdependent point of the triangle by clicking on the  button, then click at the place desired on your workspace.

Generally, any modification of the position of the interdependent point is made by means of the mouse (the arrow keys are not suited for this).






"Angle Label Arc ()"

To create an arc at any corner of the triangle, click on the button "  ". When the point changes on the workspace to  , click exactly on the corresponding vertex to the corner in question.


An arc of the circle centered at the vertex chosen appears



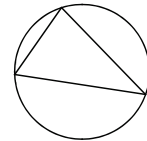
Using a process similar to that of the creation of the arc of any corner of the triangle, you could draw:

- An arc of a circle intersecting the vertices of the triangle; by using the  button.
- The median line exiting from a vertex of the triangle; by using the  button.
- The interior angle bisector exiting from a vertex of the triangle; by using the  button
- The altitude exiting from a vertex of the triangle; by using the  button.
- The segment joining the middles of two sides of the triangle, by using the  button.

"Draw circumscribed circle of a triangle ()"

To draw the circumscribed circle of a triangle, just click on the  button.

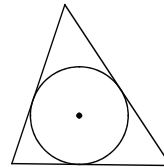
You will automatically obtain the following triangle



"Draw inscribed circle of triangle ()"

To draw the inscribed triangle, click on the  button.

You would automatically get the following figure

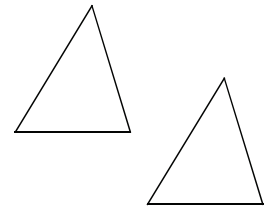



"Draw congruent triangle ()"

To draw a triangle congruent to a given triangle, click on the  button.

You would obtain in this way a triangle congruent to the initial.

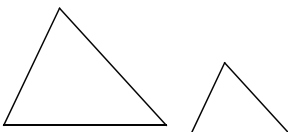
You cannot modify the size of a congruent triangle.



"Draw similar triangle ()"

To draw a triangle similar to a chosen triangle, click on the  button.

In this way, you would obtain a triangle similar to the original

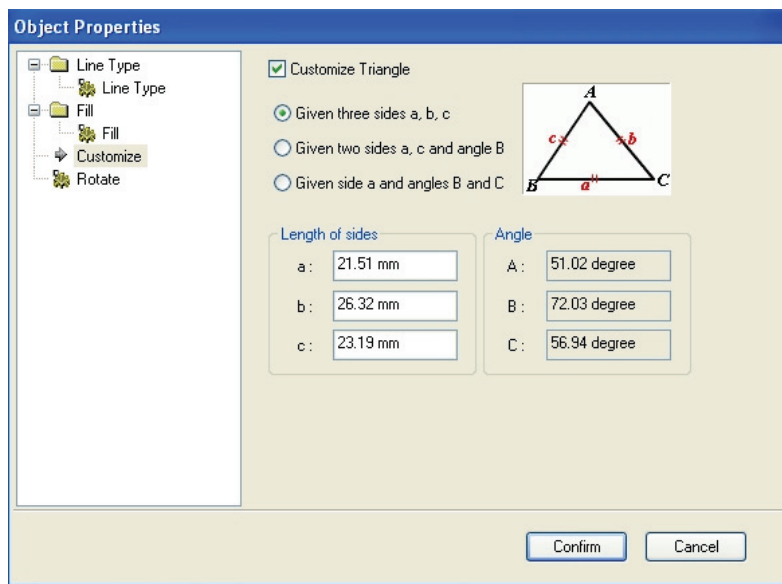


e) Object Properties dialog box

The properties of an object contain several options for carrying out modifications.

To get to properties of an "**Object Properties**" dialog box, click with the left button of the mouse on this object in order to select it; thereafter make a right-click with the mouse. Click on "**Properties**" in the contextual menu that pops up.

To illustrate the importance of the properties of an object in ScienceWord, we present below in a practical application the "**Object Properties**" of a triangle: the dialog box of this object properties provides data on various elements of the triangle. Modifications can be brought about to this triangle by acting directly on these data



To access these data, click on "Customize" and then tick off the Customize Triangle box (Customize Triangle). Then you can modify them in order to configure the triangle in another way. There are in all, three options for modifying the dimensions of the triangle. Select each of these options and make modifications accordingly to the properties of a triangle ($a \leq b + c$ and $A + B + C = 180^\circ$) and then confirm by clicking on "OK".

2) Principles of selecting drawings

Every selection of a drawing is based on the plane geometric objects, i. e. **basic geometric shapes**.

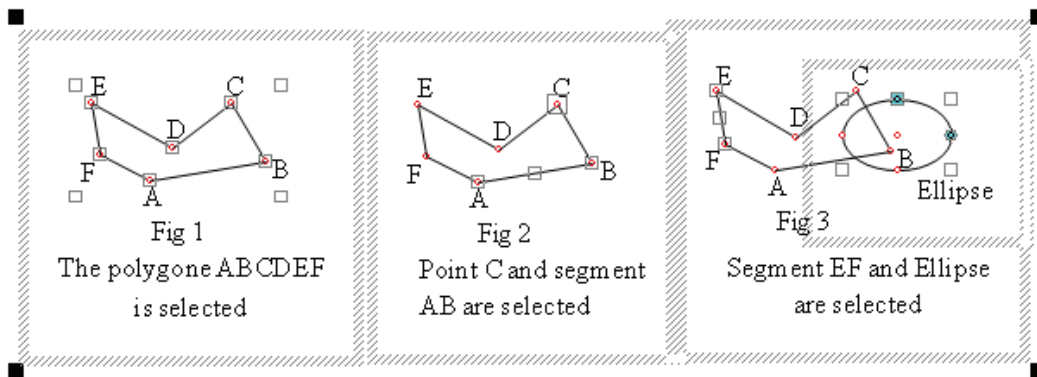
A basic shape consists of **points** or **segments** designated here by the term **elements**.

In a single selection (selection of **a single** object or of **a single element**).

i. To select a basic shape or a point, just click on this shape or this point..

- ii. To select an element of a basic geometric shape just hold down the " Ctrl" key and click on this element . Then, when the selection is done, release the Ctrl key..
During a multiple selection (selecting or deselecting **several** elements or objects), the rule is as follows, where any key used should be released at the end of this selection:
- iii. To select or deselect a point or any object, only the "Shift" key must be depressed simultaneously whilst you click on the point or the object.
- iv. To select or deselect an element of any object, both "Ctrl" and "Shift" keys must be pressed simultaneously whilst you click on the element.
- v. To cancel the whole series of selections, jsut click in the empty space.

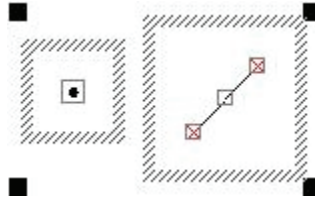

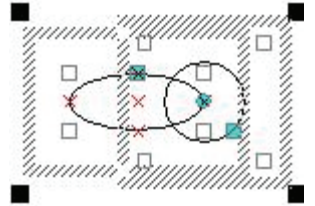
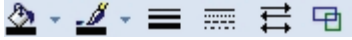
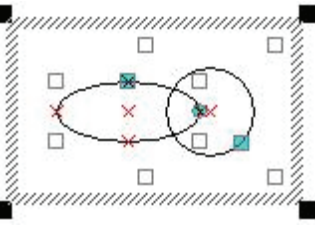

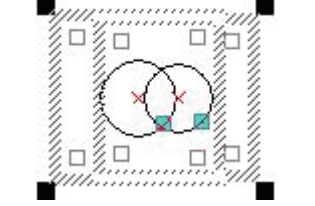
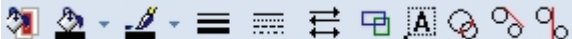
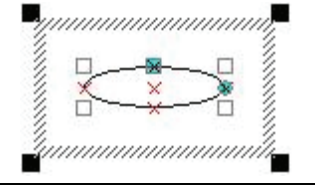

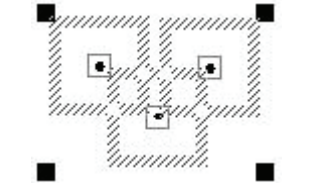
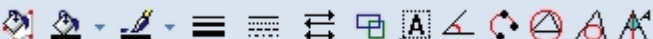


a) Examples of objects and elements selected



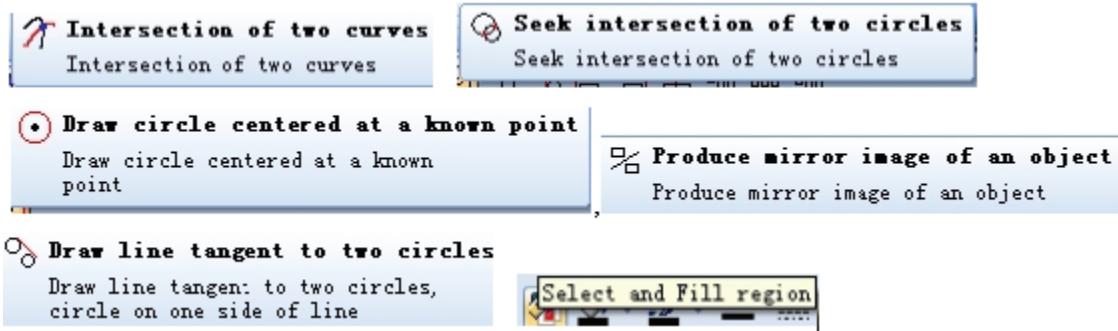
b) Selected objects and corresponding tools

We are giving in the following table some examples of objects selections and the corresponding tools that appear in geometry toolbar.

Type of selection	Appearance of the selection	Tools that appear in geometry toolbar
A point is selected		
Two points are selected		


<p>A point and a line are selected</p>		
<p>A circle and an ellipse are selected</p>		
<p>A circle and an ellipse are selected and grouped with Combine tool</p>		
<p>Two circles are selected</p>		
<p>An ellipse is selected</p>		
<p>Three points are selected</p>		
<p>Three selected points are Combined with tool</p>		

Note that you can place the pointer on the tool momentarily to make the function it executes appear as shown as follow::

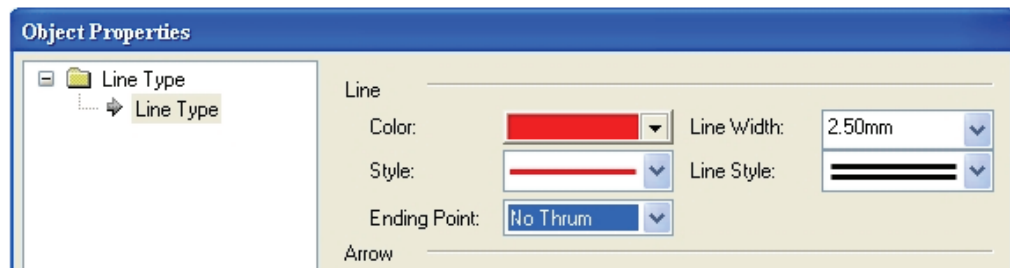


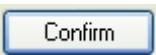
c) Practical examples

i) Example 1 (Symmetry)

- Click from the task pane on the button  in the geometry toolbar to draw six sides ordinary polygon ABCDEF. Then move the vertices in order to get the polygon as show in Fig1.

- Select the side AF, right click to access object properties dialog box and customize the line color, the line style and the ending point as shown as follow



- Click on button . Then you obtain the result as shown in Fig2.

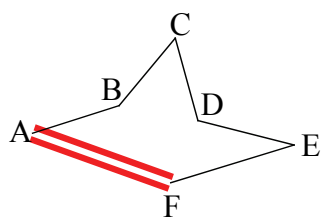


Fig 2

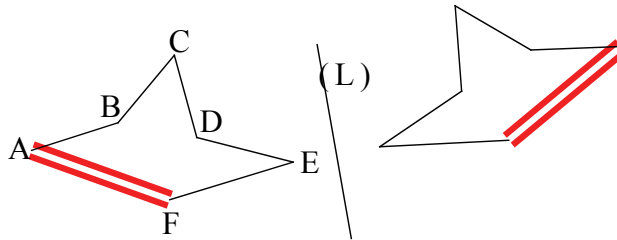



Fig 3

Select the polygon and the line in that order, then click on the icon  that pops up in the geometry toolbar to obtain the symmetry across the line (L) of the polygon (see Fig3).

ii) Example 2 (Intersection and difference of regions)

Draw a circle and an ellipse as shown in Fig4. S

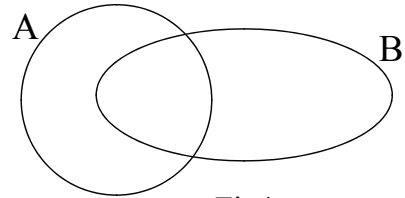



Fig4

Select them and click in geometry toolbar on the icon  Select and Fill. The result is shown in Fig5.

Click in the hatched region to select it and right click to access object properties dialog box.

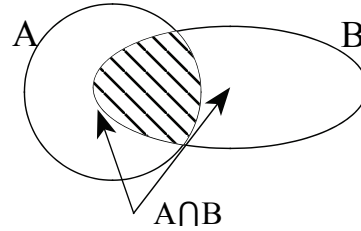
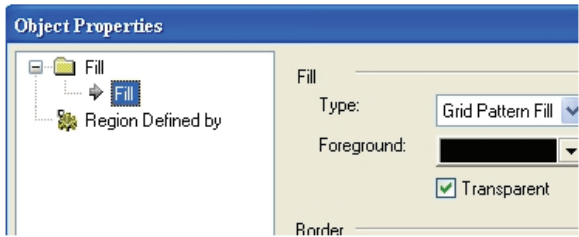
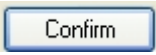


Fig 5

Select "Region defined by" and click on button  to get the following dialog box

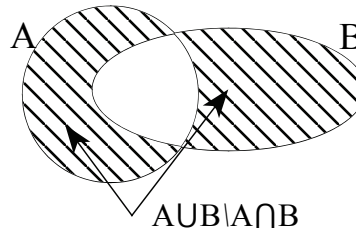
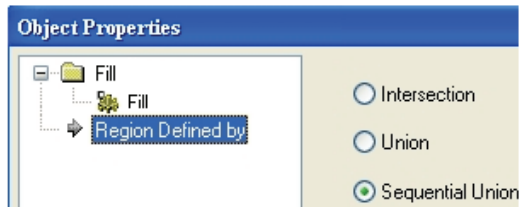
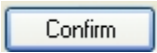


Fig 6

Check Sequential Union and click on button  to get the result of Fig6..

Remark:

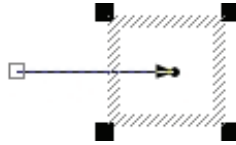
Given R_n ($n \geq 2$), the set determined by the application of the "**Sequential Union-Intersection**" option to Nsets (objects) A_1, A_2, \dots, A_n .


- If $n=2$ then, $R_2 = A_1 \cup A_2 - A_1 \cap A_2$ (see example 3 above).
- If $N=3$ then, $R_3 = R_2 \cup A_3 - R_2 \cap A_3$.
- For every integer i such as $4 \leq i \leq n$, then: $R_i = R_{i-1} \cup A_i - R_{i-1} \cap A_i$

3) Specific drawing techniques


a) The point

When the point is selected, the "Arrow ➔" tool appears in geometry toolbar; click on it. An arrow appears as the figure below shows.



Get hold of the arrow by the left end (i.e., when the pointer turns into the following shape  , click on the left end point of the arrow). Hold down the left button of the mouse depressed and then position the arrow conveniently by using slight targeted movements of the mouse. You could go to the properties of this arrow by means of the contextual menu and carry out modifications of your choice

b) The straight line

Generally to draw a line, click on  icon in the Geometry toolbar, then click on your worksheet or hold down the left button of the mouse and drag it in the appropriate direction. In the first method, we obtain an horizontal line which origin is at the upper left whereas for the second, we obtain a line of any direction which origin is the first drawn upper end

- i) To draw a horizontal or vertical line, press the "**Shift**" key whilst drawing the straight-line.
- ii) After having drawn a non-horizontal or non-vertical straight line, you could make it horizontal or vertical. To do this, keep the "**Alt**" key pressed down, get hold thereafter on one end of the line by means of the pointer of the mouse, then make movements in the appropriate direction with the mouse.
- iii) The origin of a line remains constant when its length is modify from the "Object Properties" dialog box.

c) The triangle

i) Once the triangle is selected, you can grasp directly any vertex with the pointer by clicking on that vertex.

- If you keep the left button of the mouse held down and press the key "Alt" or "Ctrl", then you will have the possibility to move the vertex initially grasped, in the direction of one side of the triangle, whilst one of the angles of this triangle is maintained in a fixed position.


- Thereafter, if you maintain the left button of the mouse held down and none of the keys "Alt" and "Ctrl" is pressed, then with the help of the mouse you can impose any shape upon the triangle.

ii) When the triangle is selected, you can also grasp directly with the pointer one of the four big black squares around the rectangular grid of the selection or one of the four small white squares inside the grid; to do so, you just need to click on one of these squares. You could also draw similar triangles with the mouse, by maintaining the left button held down.

d) The square

To draw a square, just click on the rectangle button and hold down the Shift key whilst drawing'

e) Round-angled Rectangle

Click on the  button in the toolbar and then click on the workspace. Then a rounded-angled rectangle appears, as in Fig 1 :

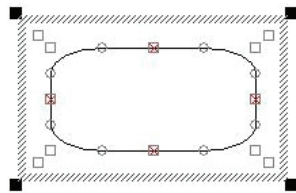


Fig 1

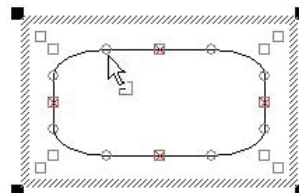



Fig 2

Take note that there are eight small rounds "O" on this rounded- angled rectangle. They serve as a support to the construction of other specific shapes of the rectangle. In the following, we shall consider four types of constructions, with a round as the departing point.

Move the pointer of the mouse to a round as shown in Fig 2..

As soon as the pointer changes to the  shape, click on the round and hold down the left button of the mouse. You could thereafter:

i) Move directly the round using small movements of the mouse; in this case, this is a total modification of the round-angled rectangle.

ii) Press the **"Shift"** key and hold it down, then move the round; in this case the modification has been made to half of the round-angled rectangle.

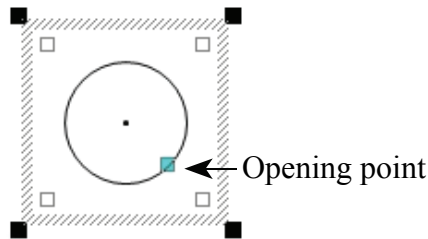
iii) Press the **"Ctrl"** key and hold it down, then move the round ; in this case, the modification has been done to half of the part of the round-angled rectangle previously modifiable in ii)

iv) Press the **"Alt"** key and hold it down, then move the round ; in this case, the modification has been done to half of the part of the round-angled rectangle previously modifiable in iii)

Remark: The tools that appear when the rounded-angled rectangle is selected and the options available in the "Object Properties " dialog box can be useful for other modifications.

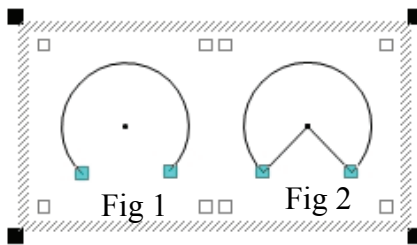
f) The opening point of the circle

Let consider the selected circle below:




The point termed the opening point of a circle is the green point by default of the circle. The radius joining this point and the horizontal line passing through the center of the circle form an angle of 45° .

Click on the opening point and hold down the left button of the mouse. Whilst you slide the mouse, make a pushing movement of the pointer towards the exterior part of the circle (Fig 1) or a movement of the pointer in the direction of the inside of the circle (Fig 2).

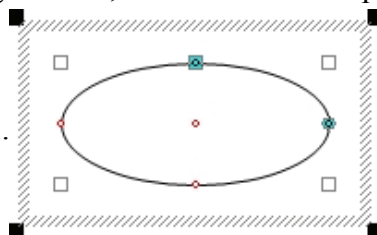


In all the cases, you would obtain an arc having two ends. You could join these two ends again, so as to get the entire circle with a different position of the opening point..

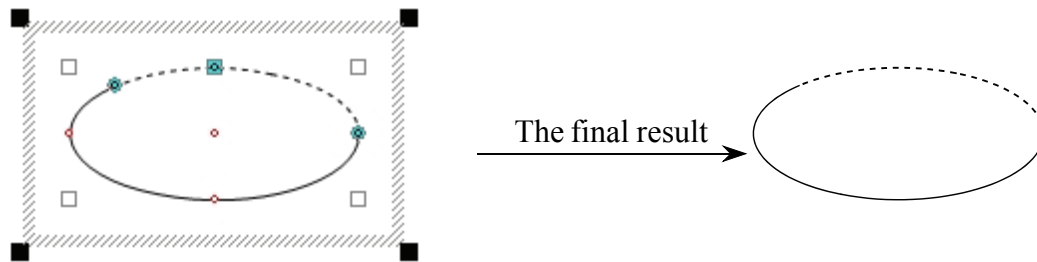
g) The opening point and dooted line point of the ellipse

Click on the  button in plane geometry toolbar, then on the workspace.

You would obtain an ellipse in this way .




You would notice that the ellipse, like the circle, possesses an opening point (the small green square) . But it also has another point (round and green) which determines the dotted line of the ellipse. To obtain such a line, click on this green point, hold down the left button of the mouse, then, using slight movements of the mouse, propel this point in a rotating motion (for example, in the anti-clockwise direction) . The dotted line depends on the new position of this green point (See the following illustration) :

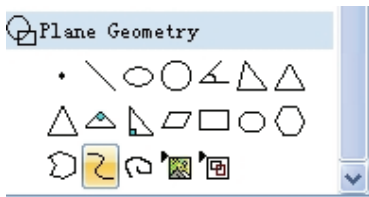


Here, the ellipse appears still selected and the green point is split. When you then click outside the ellipse, you would obtain the following final result.

As is the case with all objects, some tools appear in the geometry toolbar when the ellipse is selected. They help as ellipse properties bring about the modifications necessary for the realisation of a drawing.

h) The Bezier curve

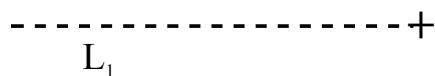
Click from "Plane Geometry " and finally on the "  button" of the Bezier curve.



The pointer changes shape to a cross (+) on the workspace. You could then draw a Bezier curve.

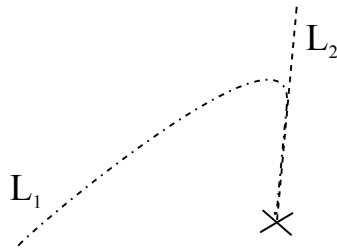
Click then on the workspace. Then a point is drawn without the cross disappearing.

i) Slide freely (horizontally for example) the mouse **without pressing** any button; then, a dotted line L_1 , appears whilst the cross is there (see the figure below) .

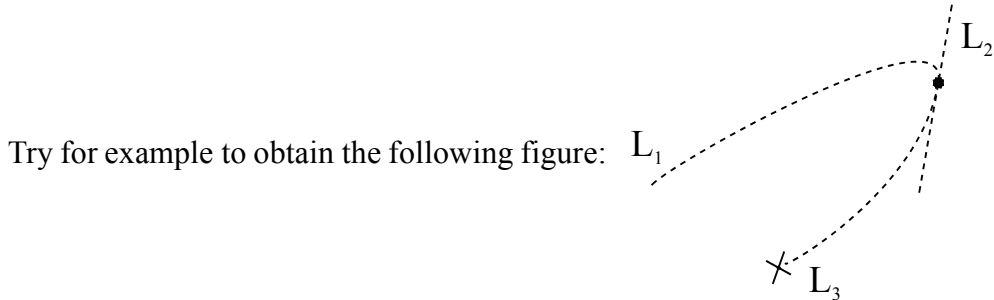


ii) Click again, hold the left button of the mouse down, then slide the mouse slightly whilst changing the direction; then a second line L_2 appears, whilst the first line L_1

curves slightly (see the following figure).




iii) Release the left button, then restart with a free movement of the mouse

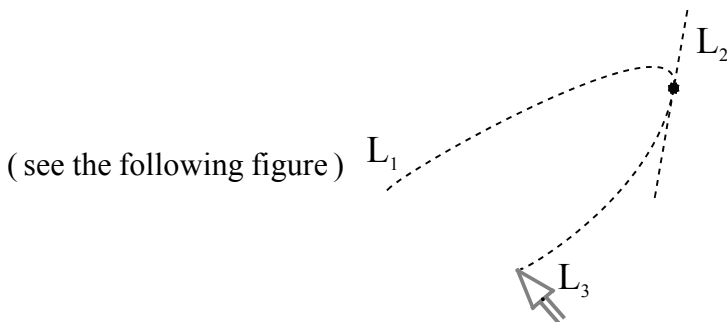


A third line L_3 is then obtained.

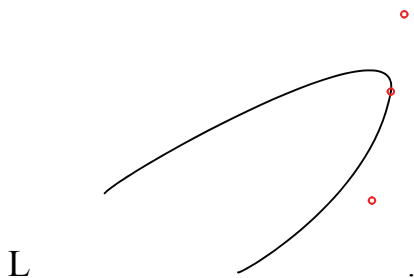
iv) We will now stop drawing.

- Click again; then a new point appears.

- Release the left button, then slide slightly the pointer in such a way as to position it beneath the new point. When the pointer changes to "  " shape, click on the new point



Now, the pointer has been freed from the curve and you would obtain the following curve

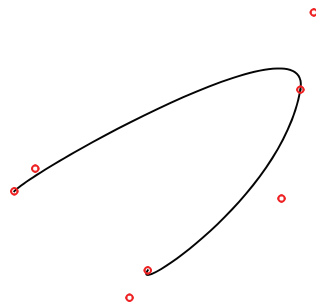


The curve L obtained is the combination of the lines L_1 and L_3 . The invisible line L_2 is

tangent to this curve at the point where the left button of the mouse had been kept held down: such a point is called a "*tangential point*". Every point on the curve that is not a tangential point is called the "*singular point*".

When the display mode of the control points is active, the ends of line L_2 can be seen. They help modify the curvature of two lines L_1 and L_3 which are both ends of the tangential point.

v) The curve L as it appears here conceals two other control points; one of these points helps to modify the curvature of L_1 and the other helps to modify the curvature of L_3 ; each of the two ends of the curve L conceals one of the points. If this is the case for the curve you have drawn, then click on one of these two ends. Press the left button of the mouse, hold it down and then move slightly the mouse. You would notice a control point that separates itself. Do the same thing to the second end.



vi) Now, you have to manipulate these control points that help modify the curvature of the line L . In this case, there are four control points (the two ends of the invisible line L_2 and the two previously isolated control points of the curve in v).

Manipulating the two previously isolated points

- Click on one of the points isolated (for example that of the side of L_1). Hold down the left button of the mouse in order to get hold of this point and then move it in different directions. Observe the different modifications of *line* L_1 .

- Click on the other isolated point and proceed as previously, then note the different modifications of *line* L_3 .

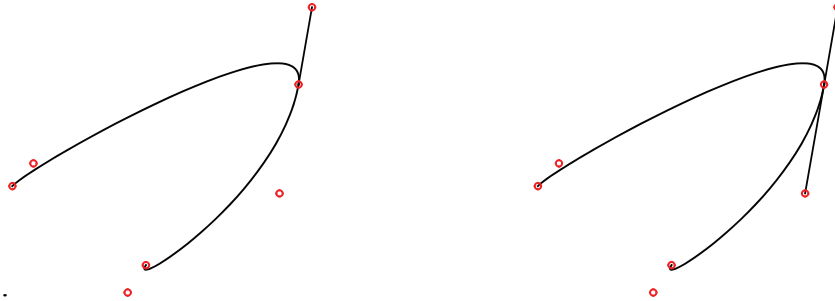
Manipulating the two ends of the invisible line L_2

- Click on any of the two ends of the invisible line L_2 , and proceed as previously, then note the different modifications of the two *lines* L_1 and L_3 .

- Click on any of the two ends of the invisible line L_2 . Hold down the left button in order to get hold of this point; press thereafter the "**Alt**" key, then move this point in different directions. Note the different modifications there are on **a single of the two lines L_1 and L_3** .

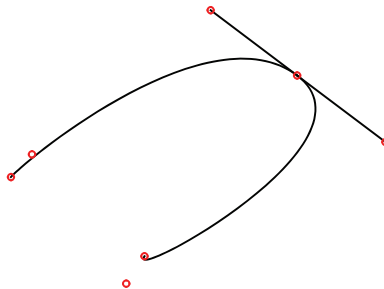
Interpreting the result

To better understand the manipulation of the ends of the invisible line L_2 , we propose that you draw **respectively the two segments** linking the said ends and the tangential point. These two segments should be moved to the bottom layer in order to help select the control points of the curvature of the curve; in other words, **select** every segment and apply to it the "**Move to Bottom**" option via "**Subject Overlay Order**". The following illustration shows the steps of depiction of the two segments (a segment gets drawn first, then finally the other) :

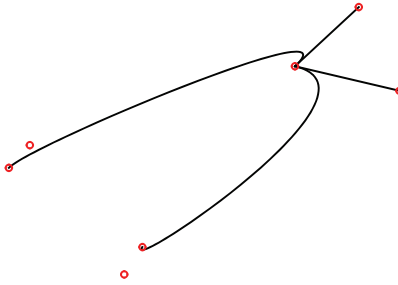


Click on any of the two ends of the invisible line L_2 previously joined at the tangential point. Get hold of it and then move it without pressing the "**Alt**" key, then move it whilst the "**Alt**" key is depressed.

In the first case, the **two portions L_1 and L_3** undergo modifications and remain any time tangent to both segments, which vary themselves as well.



In the second case, a single portion undergoes some modifications and remains any time tangent to a single segment that also varies.



Remarks:

Instead of stopping after the realisation of the line L_3 , we could have continued constructing other lines. These lines would have been obtained in the same manner, be it just after a click of the mouse or a click followed by a holding down of the left button of the mouse. At the stopping point, the same technique applied further above is used.


In the following, we are considering that the realisation of the Bezier curve proceeds whilst the pointer changes to a cross (+). The Bezier curve is considered here as a series of lines, each of them having been generated within two clicks of the mouse.

- A line is realised within two clicks on the workspace.
- The first click on the workspace begets the first end of the Bezier curve and a control point of the curvature of the first line that will be created.
- The last click on the workspace begets the second end of the Bezier curve and a control point of the curvature of the last line realised.
- An intermediary click, if it were done without the left click being made, begets a point of the curve and one control point of the curvature of the following line.
- An intermediary click, if it has done whilst the left click is being made, begets a point of the curve and two control points of the curvature of the preceding and following lines.

The manipulation of these control points by combining the "Alt" key helps limit the control of the curvature exclusively to the previous line or to the following line.

- The segment linking a point M_1 of the curve and a control point of the curvature M_2 resulting from the same click, is tangent to a line of the Bezier curve in M_1 .

i) The Bezier vector


In "Plane Geometry Graph" click on the "" button image of the Bezier vector, hold down the left button of the mouse and drag it in the appropriate direction.



This is a particular Bezier curve having just two **singular points**. The middle arrow


position can be modified with the mouse or through object properties.

j) The customized curve

- Click on the button  in the geometry toolbar.
- Click on the workspace and hold down the left button of the mouse to draw a customized curve or keep depressed any one of the "Ctrl", "Alt" and "Shift" keys whilst you draw the customised curve.

In each case, you would obtain a certain degree of flexibility of the curve.
You could customize different types of customized curve through "Object Properties".

k) Inserting an image


To insert an image into a ScienceWord document, click on the  button image in the geometry toolbar. The "Get Picture" dialog box opens up.

Find the folder in which the file of the image you want to insert into your document is, then select it and click on the "Open" button of the "Get Picture" dialog box. Then,

- if the cursor is blinking somewhere in the text or in the table, the picture appears automatically at this location into text.;
- if some drawings are previously under selection, then the cursor turns into a pencil and you need to click on a convenient location on the work page to get the image.


4) Three types of ordinary modes for drawings

a) The " Show Control Points Mode

In ScienceWord, the "Show Control Points " mode appears active by default as soon as an object is selected.

Draw for example a triangle. The small red points at the vertices are the control points of this triangle. They are characteristic points of the triangle and they help modify spatial properties of the triangle.

Deactivate this mode by clicking on the  button, then note that the control points of the triangle are no more visible.


To reactivate this mode, just click on the same  button.

In all the cases, the control points do not appear either as a preview nor in printing.

b) The Drawing Mode

In ScienceWord, when a new page is opened, the drawing mode appears inactive by default.

To enter into the drawing mode, click on the  button within the geometry toolbar. The

pointer changes to the shape  on the workspace.

In the act of drawing the usual method of selecting objects remains valid. However, we have the advantage of selecting several objects at a go.

Thus, just hold down the left button of the mouse, then slide the mouse in such a way to draw a rectangle encompassing the set of objects as shown in Fig 1.:

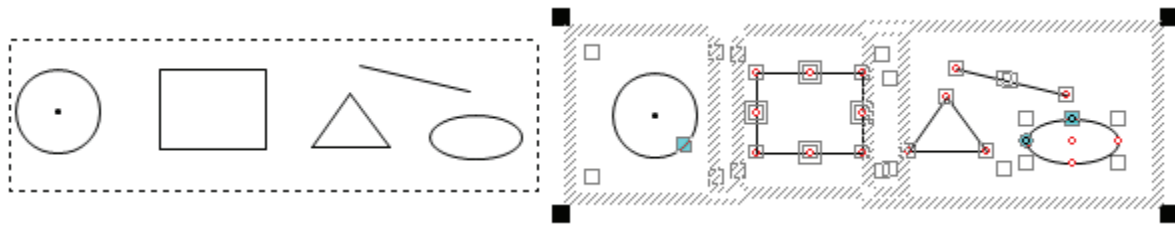



Fig 1

Fig 2


As soon as the objects appear totally surrounded, release the left button of the mouse. In the selection obtained (Fig2), the triangle, the ellipse and the straight line appear thus in the same frame because they have the same selection region; in other words, if anyone of these objects is selected, it appears in the same selection region as the frame.

- If for example you no more want the group selection (triangle, ellipse and straight lines), then hold down the "**Shift**" key, then click on the selection grid of this group. Then only this group would be unselected.

- If on the contrary you want only the selection group (triangle, ellipse and straight lines), then hold down the "**Ctrl**" key, then click on one element of this group. Thus only this group would be retained.

Remark: In the drawing mode, it is not possible to write texts. To quit the drawing mode, just click on the  button.

c) The Continuous Mode

During the opening of a new page, this mode appears inactive by default. To make it active, just click on the  button in the drawing toolbar.

When this mode is active, you could use continuously any basic geometric object (point, triangle, parallelogram, ellipse, circle, Bezier curves, customized curves, angles etc...)

To deactivate the continuous mode, click again on the  button..

5) Embedded and floating objects in ScienceWord

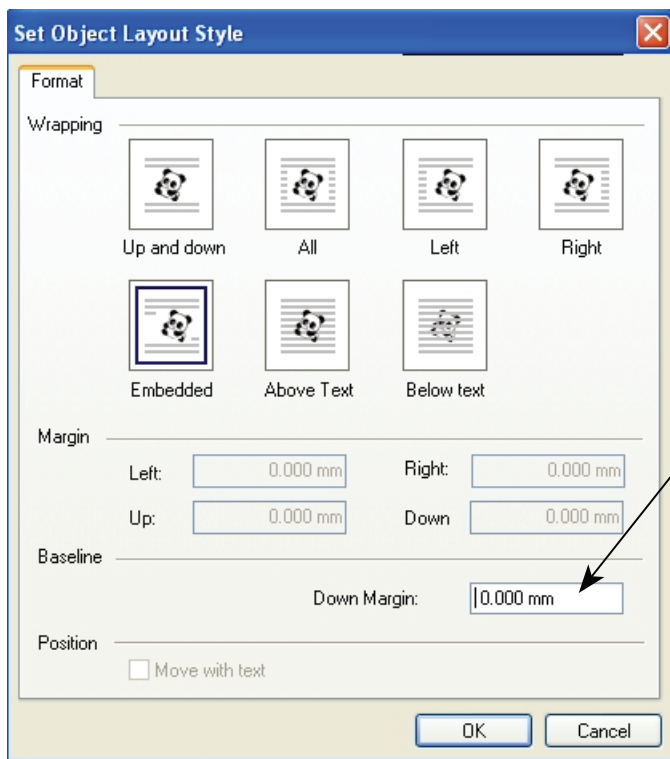
a) Embedded objects in ScienceWord

You can insert an object at any desired point into the text where the cursor blinks. Such an

object remains fixed to that point for good. It is said to be "embedded" in the text. The insertion of an object into the text is done in a stunned way in ScienceWord! Suppose that you want to insert an object anywhere in the document (even on a page different from the one where you have the drawing) . All you need is to position the cursor at the specific point, then right - click on the drawing, and then in the contextual menu, click on "Insert into text (T) ". Then the drawing is inserted exactly at the place where the cursor blinks! There are in total four types of aligning along the vertical (Base Align, Centered Align, Bottom Align, and Top Align) of the embedded object.


Note:

The alignment "Base Align" helps to position the embedded object on the baseline. On the basis of positive or negative value of the baseline "Down Margin" option in the "Set Object Layout Style" dialog box, you can move down or move up that object.



Insert a value to get a right position of the object in the text

b) Floating objects in ScienceWord

An object that is not embedded is said to be floating. Nonetheless, any floating object is linked to a paragraph. When you click on a floating object, the connecting symbol  appears on the paragraph to which the object is connected. the removal, copy or moving of the whole paragraph entails the removal, copy or moving of the connected object.

There are six options of arrangement available in the "Set Object Layout Style" dialog

box.




Floating objects as well as embedded objects can be positioned at any place of your choice.

6) Basic notions on geometry dynamic constructions

a) Variables

i) Independant variable

An independant variable is just a data taking a real value that varies in a fixed domain. It could be anything (a length, an area, a force unit, any kind of measure) . For example, in the resistance formula $R = \rho L$, the independant could mean anyone of the three variables R , ρ or L .

The independent variable tool  is available in geometry toolbar when an object of the plane is selected. The following shows two independent variables defined under different options and their corresponding dialog boxes (Fig1 and Fig2)

Independent variable 3642 = 55.00

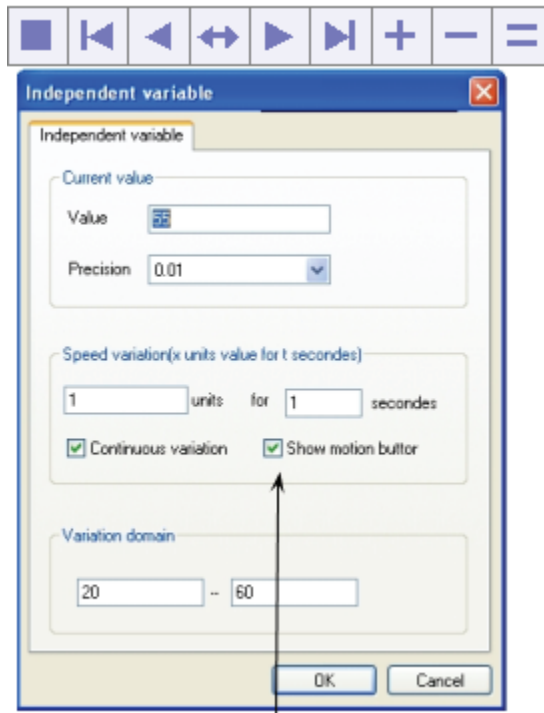


Fig1: Show motion button checked

Independent variable 3617 = 0.00

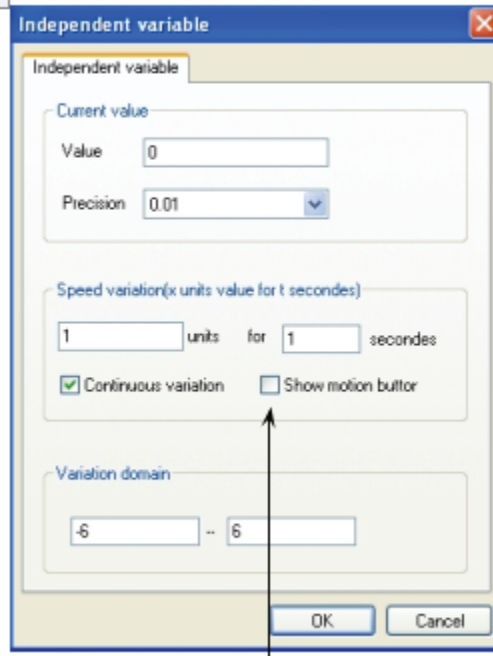


Fig2: Show motion button unchecked

ii) Functional variables

A functional variable is a function of numerical data (constant data or variable data).


Let note that a variable data could be an independent variable, a variable distance of two points of a polygon, a variable area of an ellipse, etc.

The expression of a functional variable F is made of a maximum of 15 variables (x, y, z, a, b, c, d, e, f, g, h, i, j, k, l).

For example:

$F = xy - y^2 - zx + z^3 - 1$ is a function of 3 variables.


$F = x + \frac{1}{a^2 - 2b}y - \ln(z)$ is a function 5 variables.

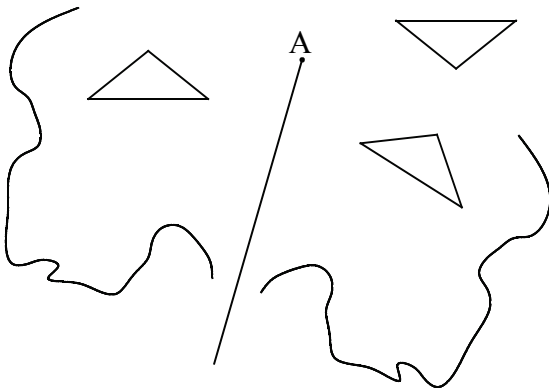
The functional variable tool  is available in geometry toolbar when an object is selected

b) Geometry transformation

Just let cite the basic ones: rotation, symmetric, translation, homothetic.

i) Symmetry of an object across a point or across a line


For the moment you can just get the symmetry of one object at once across a point or across a line. All you need to do is to select first the object and second the point or the line. Then click on the tool  that pops up automatically in geometry toolbar. The following shows the symmetry across a line and a point A of a triangle and the symmetry across a line of a free hand drawing curve.






ii) Translation of vector of several objects at once

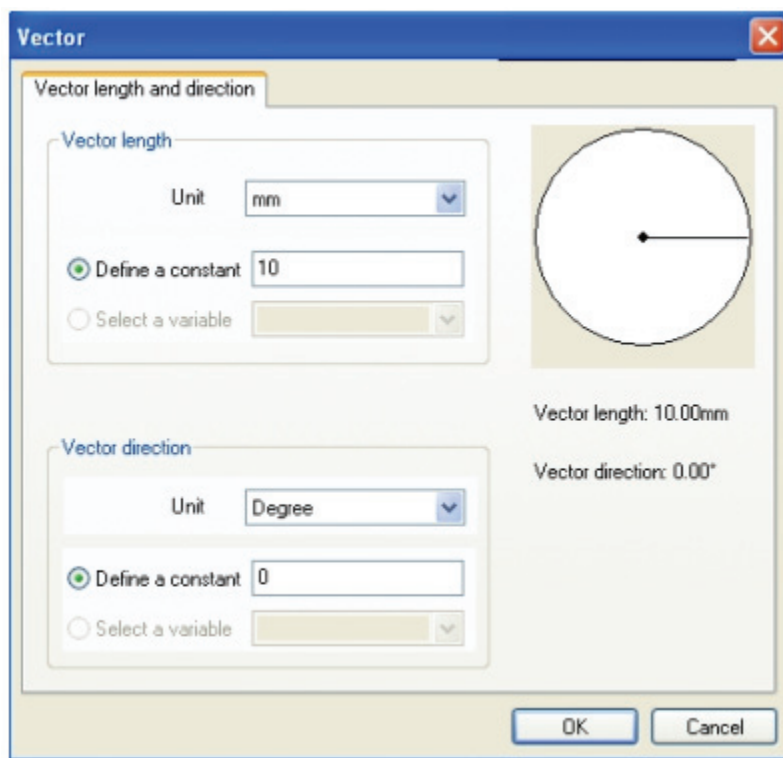
There is first a need to define a vector:

The first method consist just of selecting two points (the order of selection defines the direction) or a line where the direction is from the start to the end of that line.




Then click on the tool  that pops up automatically in geometry toolbar. Then a label is displayed on the screen showing the vector that have been defined.

Next, make sure that the defined vector and the objects to be translated belong to the same drawing region (if not. select them and click on  combine tool that pops up automatically in geometry toolbar). Then click on  tranlation vector tool. that pops up automatically to get the translation done.

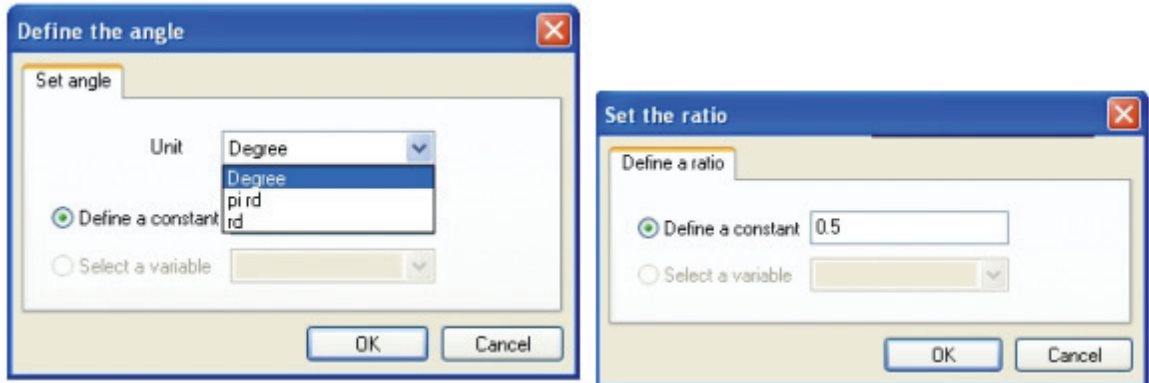
The second method of vector translation definition is based on the use of data (length and angle values) through the " Define a vector length" that appears automatically in geometry toolbar when an object is selected. Just click on this tool to get the following dialog box for settings.




iii) Rotation and homothetic of several objects

Make sure that the objects and the supposed center of the rotation or the homothety belong to the same drawing region (If not select them and click on  combine tool that pops up automatically in geometry toolbar). Select them in this order first all the objects and then the supposed center (a point) . Then click on the  rotation tool or the  homothetic tool.

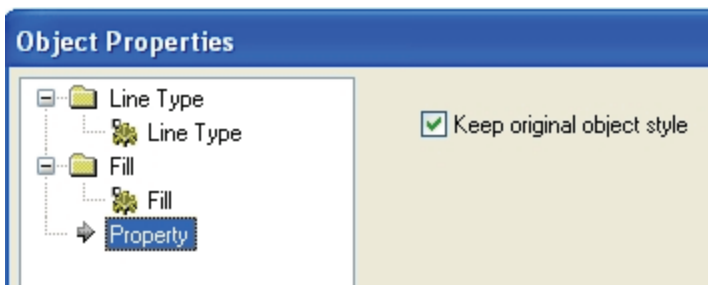
The following shows rotation dialog box and the homothety dialog box that appear for the appropriate settings



Note: To get the homothety of a point M, you may use "homothetic coefficient tool"  described as subdivision tool below. Only in this case, the order of the selection of the point M and the center changes.

iv) Geometry transforms and object style

When you apply a geometry transformation (rotation, symmetry, translation, homothetic, etc) to an object, the result is a transformed object keeping as default the same style (line color, line style, fill, etc) as the original one. The figure below shows a transformed object properties dialog box.




If you want to change the style (line style or fill) of the transformed object independently to the original one, then you have to make sure that in its object properties dialog box, the option "Keep original style" is unchecked. Otherwise any attempt to get different style to the original one will not have any effect.

c) Subdividing points of a line

i) Locating a point C of a segment AB. (Using evenly division tool)

We would like to locate a point C on the segment $[A, B]$ such that $\overline{AC} = \frac{m}{n} \overline{AB}$ ($m \in \mathbb{N}^*$, $n \in \mathbb{N}^*$ and $m < n$). In the following example we are consider $m = 2$, $n = 5$.

Select in this order point A then point B and click on the tool  that pops up automatically in the geometry toolbar. Then the dialog in Fig1 appears as default.

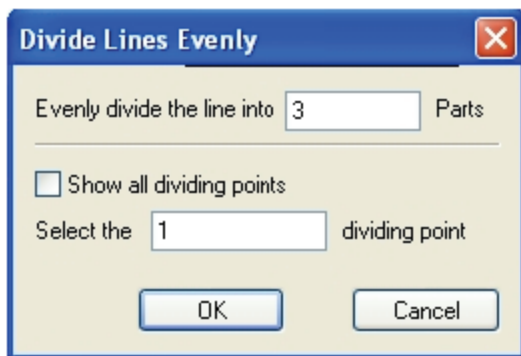


Fig1

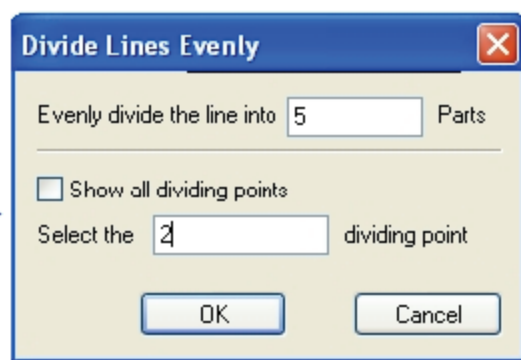


Fig2

Customize the dialog box as shown in Fig2 and click on "OK", see illustration (Fig3).

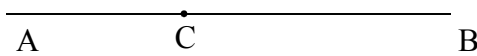



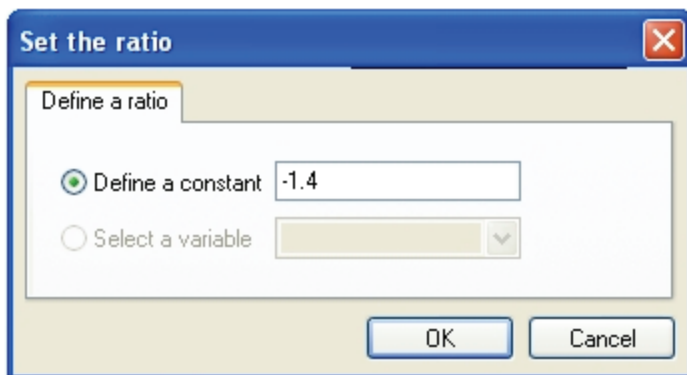
Fig3

Note: If you check "Show all dividing points", then you will get four points that ensure the subdivision of AB segment is in five equal parts.

ii) Locating a point C of a line (AB) (Using the ratio tool)

We would like to locate a point C of the line (A, B) such that $\overline{AC} = \lambda \overline{AB}$ ($\lambda \in \mathbb{R}^*$)

Select in this order point A then point B and click on the tool  that pops up automatically in the geometry toolbar. Then, in the dialog box that appears, type for example - 1.4 ($\lambda = -1.4$) in "Define a constant" slot as shown below.



Click on "OK" button to get the result. (see Fig 4)

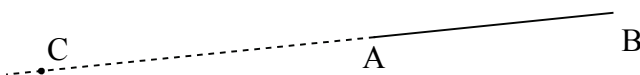


Fig 4



Note:

➤ This dialog box allows to use variable ratio. When a variable is defined, you can check the box "Select a variable".

➤ The ratio could just be a complex constant as $\frac{\sqrt{3} + \sqrt{2} \sin(0.3\pi)}{\sqrt{31} - \sqrt{7}}$. In this case it should be very easy to define it as functional variable.

➤ You can use variable ratio to divide a segment into n equal parts. You have just to define a functional variable $\frac{m}{n}$ when n is a constant natural number and m an independent natural number variable between 1 and n . Then using the technique of generating track of target motion (next topic), you would get the result. This technique could be very useful for the animation of objects linked with the divided points of a segment.

iii) Measure of a point M of a line (OI)

Draw a segment OI and click on the tool " Select a point of a line". Then select a point M on the segment or on the extension of this segment as shown below. Then click on the tool " Ratio" that becomes automatically available in geometry toolbar. Then a measure is displayed as shown below and here it means: $\overline{OM} = 2.3324 \overline{OI}$


Measure 18897: Homothety coefficient on the segment of M = 2.3324



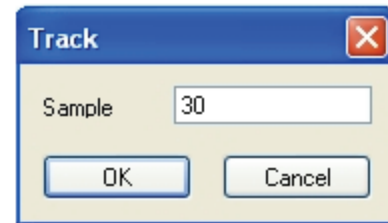
d) Track of a target in motion

You can select a point from a segment, a polygon, a circle or an ellipse and through Insert menu get its animation button.

You can define an independant variable and through Insert menu get its animation button. This kind of variables having an animation button could involve motion of others objects that construction depend on them. Then to see all the positions occupied by these objects, select first the variable (the previously said point or indepenent variable) and then the object. Then click in the geometry toolbar of the the

" Display the track of the target motion". The opposite dialog opens up .


Write the appropriate number and click on "OK" button. You can, through properties or motion properties dialog box (right click on the result to see properties and

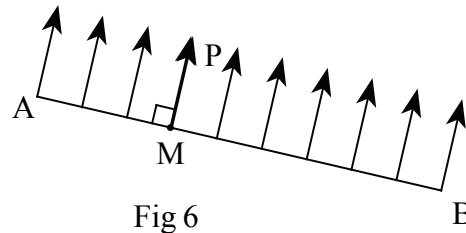
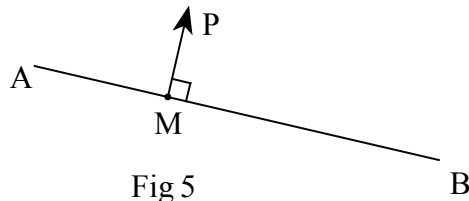


motion properties) modify the result obtained

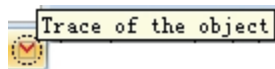
Example

Draw a segment [AB] and select a point M of this segment. Then draw the vector \vec{MP} perpendicular to [AB] as shown in Fig 5.

Then select the point M and the vector \vec{MP} in this order and click on " Display the track of the target motion" tool in geometry toolbar.. In the track dialog box that appears, write 10. Click on OK to get the result in Fig 6



Note: In PagePlayer when an object is selected you can click on the trace button




to show the trace of that object during the object motion.. The



button clean helps to clean object traces.

e) Color variation

You can make use of any variable value to get a color variation of an object. You just have to select that object and that variable (this selection could be done in any order) .

Then click " Object color in relation with the parameter variation" to set the color parameters. Then you can get the variation of the object color when the variable takes different values.

f) Buttons of animation

There exist four kinds of animation button: Show /hide button, Animation button, Series button and Displace button. You can get them from Insert menu → Control buttons..

You can bring modifications to these buttons through their motion properties dialog box.

i) Show /hide button

When a series of object or a series of objects elements of a same drawing region are selected, this button is automatically activated. Then you can insert it and make use of it as tool of a drawing animation.

ii) Animation buttons

When an object or a point of this is selected, the animation button is automatically

activated. It is particularly very useful for the point animation on a segment, on a polygon, on a circle, on an ellipse or on an arc passing three points.

iii) Displace button


This button is activated only when two points of a same drawing region are selected and the second point selected is displaceable. Then you use it to move the second selected point to the level of the first one.

iv) Series button



This button is activated when two of the three buttons (Show/Hide, Animation button, Displace button) or all these three buttons of a same drawing region are selected. You can customize the series button from its motion properties dialog box for a series of actions to be taken .


Note


Let remind that two or more objects belong to the same drawing region when under selection they are surrounding by only one grid.

You can merge two or more drawing regions into one drawing region with the " Combine tool".

g) Geometry toolbar "Hide" and "Show" tools

When a drawing is selected or when an object is drawn, the tools " Hide the selected objects" and " Show the hidden objects" are automatically available in geometry toolbar. They are not associated at any particular objects as the previously defined animation buttons are.


The tool  helps to hide any object selected.








The tool  helps to show all the hidden objects in the drawing zone. As it is said, this object is available only when an object is selected . If all the objects of the worksheet have been previously hidden, you need to draw a new object in order to access this tool and then you may be able to show all the hidden objects.

h) Measures

i) Types of measures

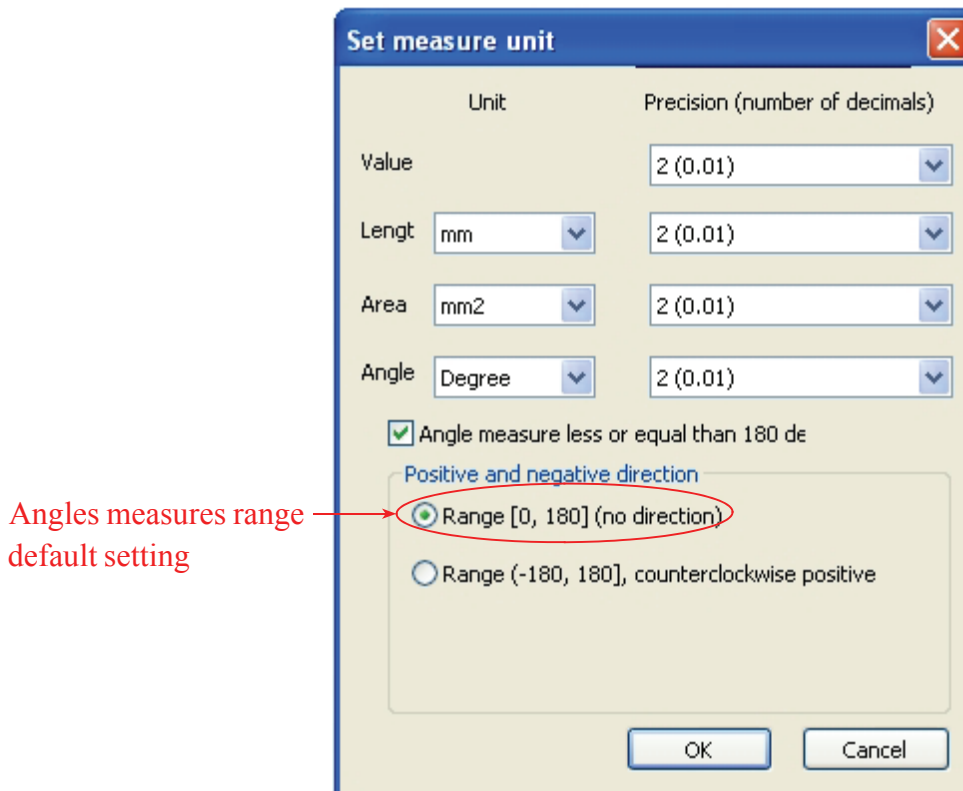
In the following table we are describing the different tools available for measures.

Measures	
Measures icons	Specific tasks to be carried out when working in a drawing region
 Length	Used to display a length of a segment

 Distance	Used to display the distance between two points or a distance from a point to a line
 Perimeter	Used to display the perimeter of a polygone, a circle, an ellipse
 Length of arc	Used to display the length of an arc passing three points or an arc defined by two points of a circle or an circle arc ,
 Arc measure	Used to display the measure in degree (as default) of an arc defined by two point of a circle or an circle arc or the measure of the polar angle of a point of a circle or a circle arc
 Radius	Used to display the radius of a circle
 Angle	Used to display the angle measure of two rays (as default between 0 and 180°) or the positive and negative angles of these rays.
 Area	Used to display the area of a triangle or a quadrilateral or domain defined by three or four points or any regular polygon.

ii) Measures units settings

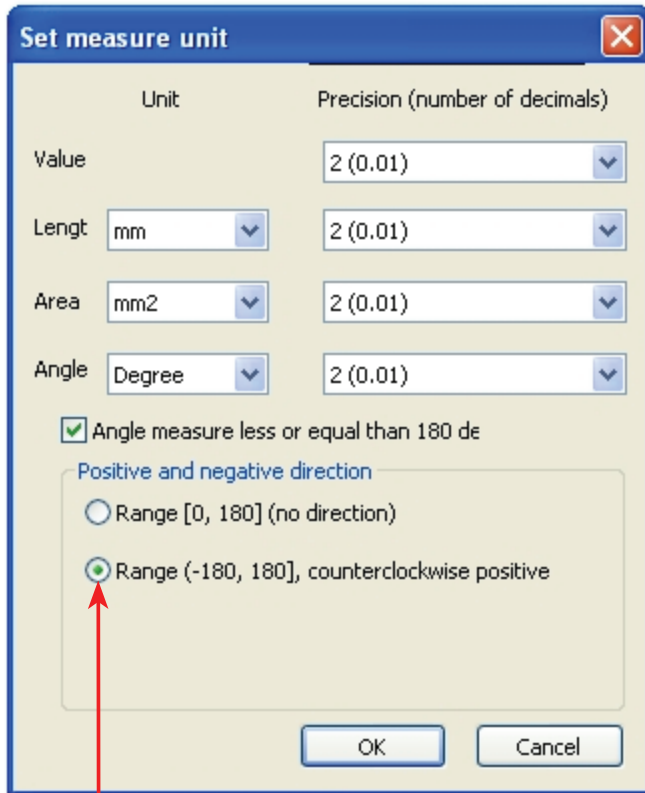
Click in Format menu on "Set measure unit". Then the following dialog box appears



You can change the default settings. The angle unit can be set as: ° (degree) , rd or πrd. The length unit can be set as: mm, cm or inch. The area unit can be set as mm², cm² or inch². Each kind of measure precision can be set as a value between 0 and 5. The angles measures range are set as default "less or equal than 180 degrees" with the

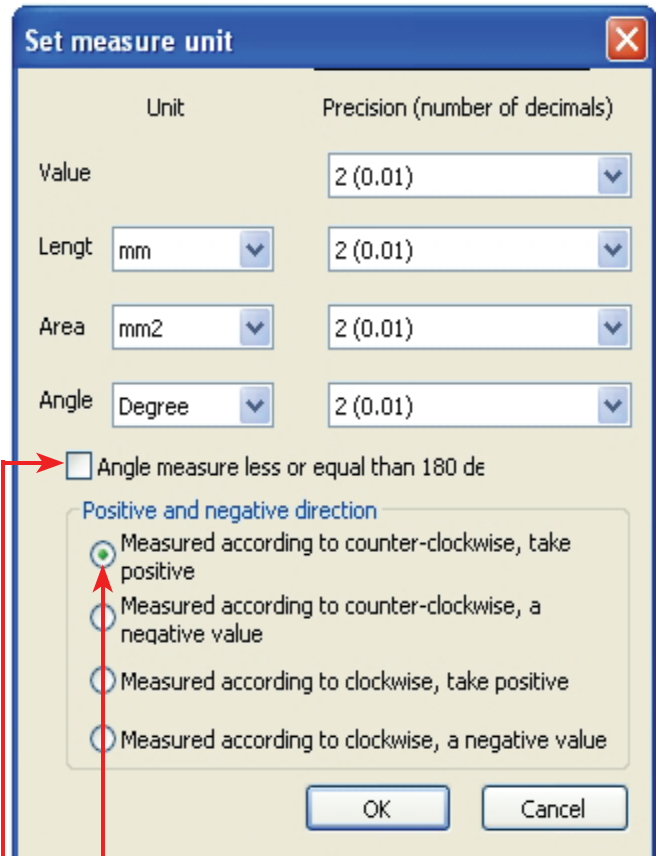
option " Range [0, 180] (no direction)". This kind of limitation is only suitable when dealing with geometrical angle measures (see 7 } a } i } **Measure of the smallest angular sector**).

Most often when dealing with technical and engineering drawings there is a need to use angles measures with direction. Then you just need to set the default option "less or equal than 180 degrees" with the option " Range (-180, 180] counterclockwise positive)" (Fig1) or just uncheck the option "less or equal than 180 degrees" (Fig2).



Positive and negative measures less than 180 degrees

Fig 1




Measures between 0 and 360 degrees Unchecked box

Fig 2

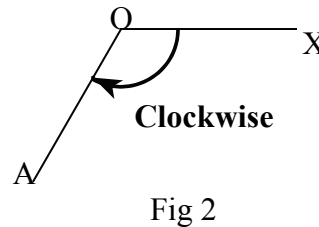
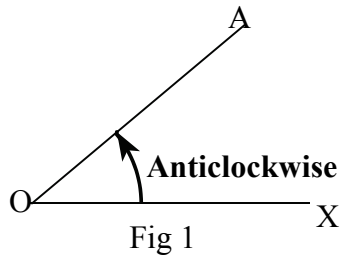
.7) Angle notation and measures

a) The option of "Angle measure less or equal than 180° "

Let draw a segment OX and consider the following two cases of rotation of this segment about O to get a segment OA: the rotation of 40° (Fig1) and the rotation of 240° (Fig2).

Let remind that to rotate the segment OX about O, you have to select in this order the segment OX and the point O; then click on the rotation  icon that appears in geometry

toolbar to carry out the rotation.



Given the two rays $[OX)$ and $[OA)$, there exists only one rotation through the shortest way that maps $[OX)$ onto $[OA)$ (anticlockwise in Fig1 or clockwise in Fig2)..

i) Measure of the smallest angular sector defined by $[OX)$ and $[OA)$

There is no difference for the measurement of the smallest angular sector defined by these two rays $[OX)$ and $[OA)$ when mapping $[OX)$ onto $[OA)$ or $[OA)$ onto $[OX)$. To get this measurement, first make sure that the option "⊙ Range $[0, 180]$ (no direction) of "measure less or equal than 180° " in Set measure unit dialog box is selected..

Then select in this order A, O, X and click on the tool "Measure $\sphericalangle =$ " in geometry toolbar. Then the measures of $\sphericalangle AOX$ is displayed as follows:

Measure 39 $\sphericalangle AOX = 40.0^\circ$ (Fig1); Measure 40 $\sphericalangle AOX = 120.0^\circ$ (Fig 2)..

You could also select in this order X, O, A. Then you would get the same result as follows: Measure 41 $\sphericalangle XOA = 40.0^\circ$ (Fig1) ; Measure 42 $\sphericalangle XOA = 120.0^\circ$ (Fig2.)

ii) Positive and negative angles with anticlockwise as positive direction

The rotation that maps $[OX)$ onto $[OA)$ is said positive when it is done anticlockwise and negative when it is done clockwise. This is a convention universally adopted.

Now make sure that the option "⊙ Range $[-180, 180]$, counterclockwise positive" of "measure less or equal than 180 degrees " in Set measure unit dialog box is selected..

To get the measure of the angle rotation that maps $[OX)$ onto $[OA)$, select in this order X, O and A and click on the tool "Measure $\sphericalangle =$ " in geometry toolbar. The result displayed as follows:

Measure 43 $\sphericalangle XOA = 40.0^\circ$ (Fig1) ; Measure 44 $\sphericalangle XOA = -120.0^\circ$ (Fig2) ..

Other notation of the Angle XOA is (\vec{OX}, \vec{OA}) . This notation shows clearly that the started side of this angle is $[OX)$ and the end side $[OA)$,.

To get the measure of the angle rotation that maps $[OA)$ onto $[OX)$, select in this

order A, O and X. Then you will get:

Measure 45 AngleAOX = -40.0° (Fig1); Measure 46 AngleAOX = 120.0° (Fig2)..

Other notation of the Angle AOX is (\vec{OA}, \vec{OX}) .

b) The option "Angle measure less or equal than 180° " is unchecked

This is the case where there is no constraint of bounded value of rotation angle that maps $[OX)$ onto $[OA)$. And this can be done clockwise or anticlockwise see Fig3 and Fig4.

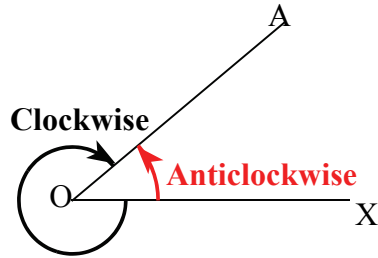


Fig 3

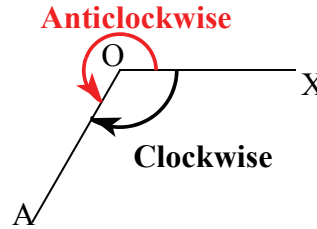
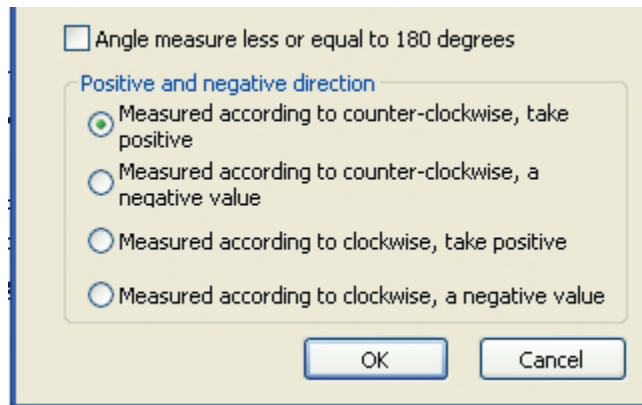


Fig 4

The constraints of each option as shown below insure that all the angles measures have the same sign and the rotation angle that maps $[OX)$ onto $[OA)$ under consideration is only one way: clockwise or anticlockwise.



Any option including "Take positive" criteria helps to display the only one positive value of the interval $[0, 360^\circ[$ that corresponds to the angle.

Any option including "Take negative" criteria helps to display the only one negative value of the interval $] -360^\circ, 0]$ that corresponds to the angle.

For example,

if the option " Measured according to the counter-clockwise, take positive" is checked, then you will get the following results

Measure 1214 AngleXOA = 40.0° (Fig1); Measure 1215 AngleXOA = 240.0° (Fig2).

Measure 1216 AngleAOX = 320.0° (Fig1); Measure 1217 AngleAOX = 120.0° (Fig2).

If the option the option " Measured according to the counter-clockwise, a negative value" is checked, then you will get the following results

Measure1218AngleXOA = -40° (Fig1); Measure1219AngleXOA = -240° (Fig2).
 Measure1220AngleAOX = -320° (Fig1); Measure1221AngleAOX = -120° (Fig2).

If the option the option " Measured according to the clockwise, take positive" is checked, then you will get the following results

Measure1222AngleXOA = 320.0° (Fig1); Measure1223AngleXOA = 120.0° (Fig2)..
 Measure1224AngleAOX = 40.0° (Fig1); Measure1225AngleAOX = 240.0° (Fig2)



If the option the option " Measured according to the clockwise, a negative value" is checked, then you will get the following results

Measure1226AngleXOA = -320° (Fig1); Measure1227AngleXOA = -120° (Fig2)..
 Measure1228AngleAOX = -40° (Fig1); Measure1229AngleAOX = -240° (Fig2)

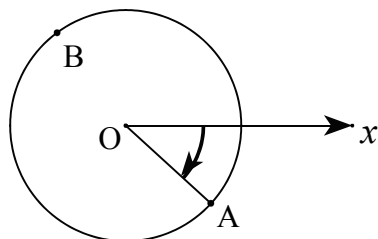
Notes:

You can change the displayed measure option of "Angle AOX " in its motion properties dialog box. To access this dialog box, select the displayed measure, and right-click; then in the contextual menu that opens up click on "motion properties". You can also just double-click on that displayed measure to access the motion properties dialog box.

c) Polar angle - Circle arc notations and measures

When you select a point A of a circle, the icon " Arc measure". appears in geometry toolbar and helps to display the polar angle value of that point of the circle, that is Angle xOA or (\vec{Ox}, \vec{OA}) value. When you select two points A and B of a circle, the same icon " Arc measure" appears in geometry toolbar and helps to display the arc measure of the arc defined by these two points of the circle. (see Fig5, Fig5, Fig7, Fig8, Fig9 and Fig10).

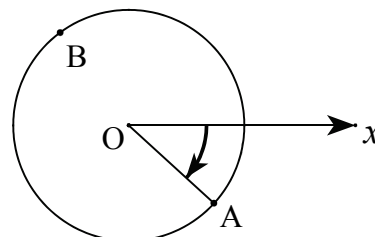
Measure of the arc AB = 168.91°
 Measure of the arc BA = 168.91°
 Measure of A = 42.43°



Option: Angle measure less or equal than 180°
 Range $[0, 180]$, no direction

Fig 5

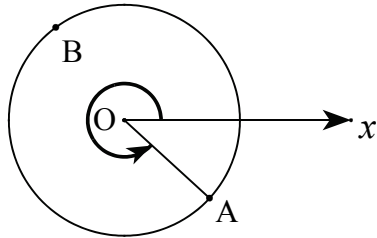
Measure of the arc AB = 168.91°
 Measure of the arc BA = -168.91°
 Measure of A = -42.43°



Option: Angle measure less or equal than 180°
 Range $[-180, 180]$, counter-clockwise

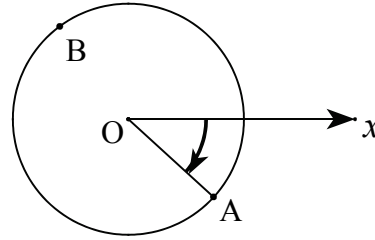
Fig 6

Measure of the arc AB = 168.91°
 Measure of the arc BA = 191.09°
 Measure of A = 317.57°



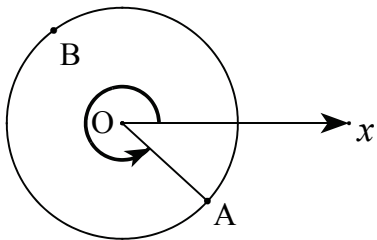
⊙ Measured according to the counter-clockwise, take positive Fig 7

Measure of the arc AB = -191.09°
 Measure of the arc BA = -168.91°
 Measure of A = -42.43°



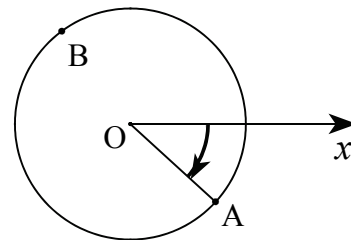
⊙ Measured according to clockwise, a negative value Fig 8

Measure of the arc AB = -168.91°
 Measure of the arc BA = -191.09°
 Measure of A = -317.57°



⊙ Measured according to the counter-clockwise, a negative value Fig 9

Measure of the arc AB = 191.09°
 Measure of the arc BA = 168.91°
 Measure of A = 42.43°



⊙ Measured according to clockwise, take positive Fig 10

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