Drawings and dynamic constructions

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I - Drawing zone

1) Notion of drawing zone

Any object drawn belongs automatically to a drawing zone highlighted by a rectangular grid. The illustrations below show two cases: of drawing zone of a point: the first one when this point is selected (Fig1) and a the second one when this point is not selected. (or deselected) (Fig2) .

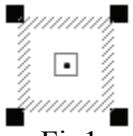


Fig1

Fig2

Fig 3

Let just say that in Fig1 and Fg2 the drawing zone of the point is selected. In Fig3 the drawing zone of the point is not selected (or deselected) ; then the four black squares shown in Fig1 and Fig2 are not visible. But you can still take the pointer of the mouse to the position of any non visible black square; when a correct position is reached the pointer turns into an arrow and you just have to click to get the same result as in Fig2.

2) Merging several drawing zones

Let draw two points A and B having different drawing zones as illustrated by Fig1 and Fig2 in **1)** . Click in geometry toolbar on the line tool and join point A and point B The illustration in Fig3 shows the link being done when that of Fig4 is the result.

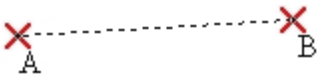


Fig 3

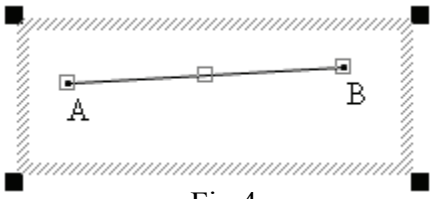


Fig 4

This result shows that A and B belong now to the same drawing zone. In other words, just say that the drawing zones of A and B have been merged. There are many similar cases where two or more drawing zones are merged..

But you can merge the drawing zones of A and B without linking them with a line. Just select point A and point B and click on "Combine " tool that becomes available in geometry toolbar.

In general, the combine tool is available in geometry toolbar only when two or more drawing zones are selected! Upon clicking on it all the selected drawing zones are merged into one drawing zone. Note that any imported image belongs to a drawing zone!

3) Properties of drawing zone

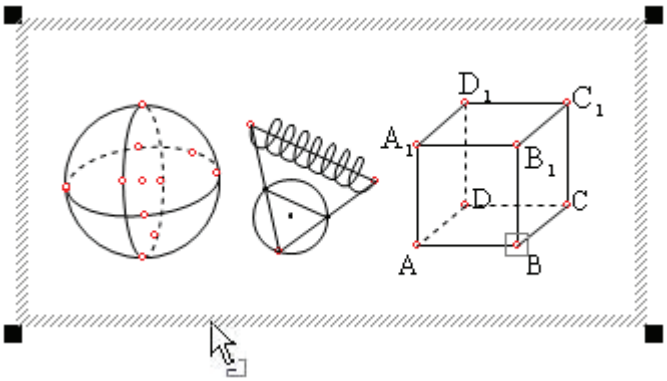
a) Shift objects of the drawing zone

A drawing zone is in fact a kind of result of partial grouping of objects where every object keeps its relative independence..

For example, in Fig4 you can select A point and shift it with the help of the mouse or using any arrow key of the keyboard. When points A and B are selected you can move them with the mouse or any arrow key of the key board too.

But the segment AB is not like a free line that can be moved with any arrow key of the keyboard. However you can shift it with the mouse. First, just click on AB to select it, then move the pointer of the mouse at its level; then when the pointer turns into the arrow form. , hold on the left button of the mouse and drag it.

In any case, you can shift any drawing zone. Just move the pointer of the mouse to the grid of that drawing zone and when the pointer turns into arrow form, just hold down the left button of the mouse and drag it (see illustration below) ..



b) Objects of a drawing zone share data

Geometry transformations using variables can be applied only to objects belonging the same drawing region.

When applying such transformations to objects, just make sure that these objects belong the same drawing region. if not, select them and use the combine tool to merge their drawing regions.

4) The total grouping tool

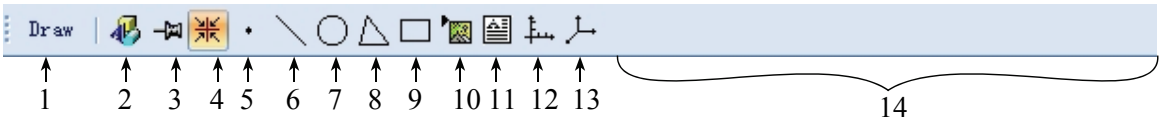
The "Group " tool can be used to group all kinds of objects. When this is done you cannot access any one of these objects until you ungroup them with the " Ungroup "

tool. The "Group " and " Ungroup " tools can be found in Format menu.

II - Common basic drawings

1) Geometry toolbar

The geometry toolbar is the toolbar where most of the tasks to complete drawings and geometry dynamic constructions are carried out. It appears as default with just few tools:



1- Button draw gives access to all science graphics tools pane;

2- The drawing mode: when it is activated you can select several objects at a go; you can click in the working area without moving the cursor into text and keep focusing in the drawing aspect whereas you are allowed to write in text box, in Super Label text box, in label dialog box or any area where the "Add Text" option have been applied to. To go back to typing your document, you have to deactivate the drawing mode. Remember that to activate or deactivate the drawing mode you just have to click on this button.

3- .The continuous mode button: when it is activated, you can continuously make use of any basic geometric object (point, line, triangle, parallelogram, ellipse, circle, Bezier curves, customized curves, angles etc…) . To activate or deactivate the continuous mode you just have to click on this button.

4- Show Control Points mode button: it appears activated by default and enables to see all control points in any selected drawing zone. When it is deactivated, you may not be able to see these control points. To deactivate or activate the Show Control Points mode you just have to click on this button.

5-Point; 6-Line; 7-Circle; 8-Triangle; 9-Rectangle are the five most basic geometry tools available by default in geometry toolbar.

10- Insert image button: it helps to import image.

11- Text box button; 12- 2D coordinates system button; 13- 3D coordinates system button.

14- Geometry toolbar tasks zone: this is the zone where you have to find necessary tools that appear automatically when objects are selected. To know a tool function, just place the pointer of the mouse on this tool momentarily to make the function it executes appear.

2) Drawing Basic tools

To access the complete list of drawing basic objects, just click on Task Pane drop-down button (see Fig 1) and then click on Science Graphics.

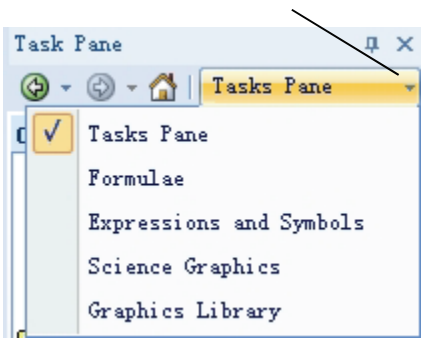


Fig 1

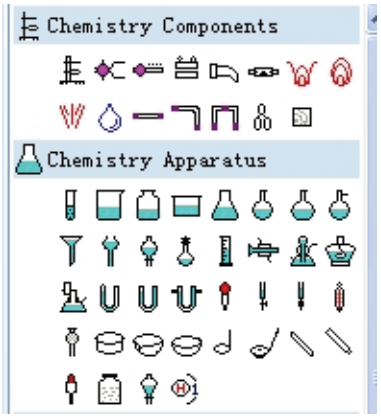


Fig 2

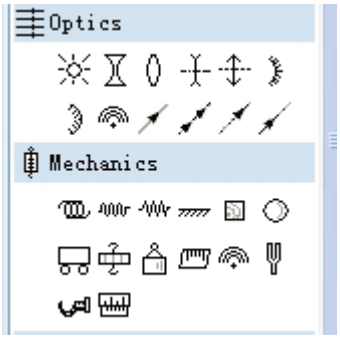


Fig 3

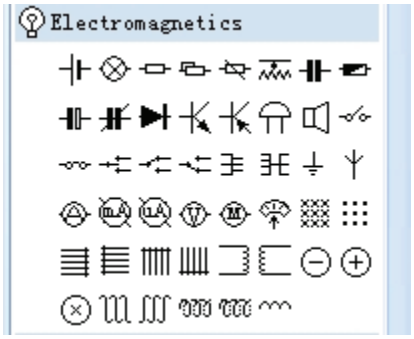


Fig 4

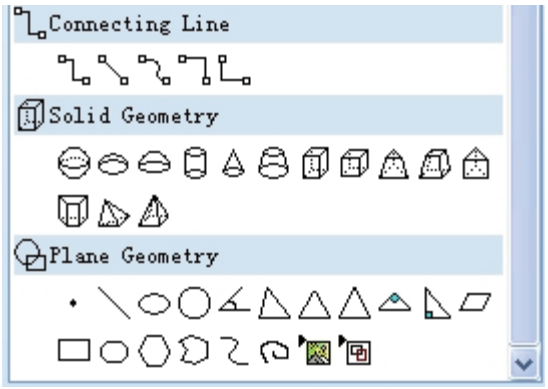


Fig 5

The list of Science graphics objects is made of chemistry components, chemistry apparatus (Fig 2) , Optics and Mechanics objects (Fig3) , Electromagnetism objects (Fig4) , Connecting Lines, Solid Geometry and Plane Geometry objects (Fig5) .

The button Draw of geometry toolbar as said in 1) gives access to all science graphics panes too with the possibility to drag them to any position on the work sheet..

You can access to an additional extendable images list upon clicking. in task pane on Useful images (see Fig1) .

In this document we are working with Plane Geometry objects, solid Geometry objects and connecting lines as shown in Fig5.

3) Drawing directly points, lines, circles and ellipses: Practical examples

There are many ways to draw points, lines (including polygons) , circles and ellipses. But the user may be more efficient if he understands some very simple aspects of drawing. This topic exposes some natural ways of drawing (the same way we do when we are drawing them with a pencil, but intelligible!) . This is an important start up to handle drawing in ScienceWord and PagePlayer.

We are then proposing some practical exercises. The user should like to try them first and then look at the solutions. These solutions are not the best ones; they just describe a way. to complete them and make sure that the user is well prepared to carry out the following tasks. There are many ways to get the same result.

a) Dealing with points, segments and objects selection

Exercise1:

i. Draw a point and label it A.

ii. Draw four other non aligned points and name them B, C, D, E

iii. Draw five lines that join A and B, B and C, C and D, D and E, E and A.

iv. Arrange these five points A, B, C, D, E to get a five sides convex polygon..

v. Select AB side (just click with the mouse on AB) and click in Geometry toolbar tasks zone on the tool " Draw bisecting point. . . " to get the middle point of AB segment. Then, draw in the same way the middle point of BC, CD, DE and EA segments

vi. Label in this order I_1, J_1, K_1, M_1 and L_1 these middle points of AB, BC, CD, DE, EA segments.

Solution

i. Click in geometry toolbar on " Draw point" tool and move the pointer of the mouse to the working sheet. The pointer turns into pencil form . Just click at a desired position on the work sheet to get a point drawn. As the point is still selected, the " Label Object " tool is automatically available; click on this tool and type the letter A in the dialog box that opens up. Then click OK.

ii. As you have to complete the same action repeatedly, activate the continuous mode button in the geometry toolbar and click on "Draw point " tool. Move the pointer of the mouse to the working sheet and click continuously in four different positions to get four additional points drawn.

Now you can label at once all the four points newly drawn. To do so, hold down the Shift

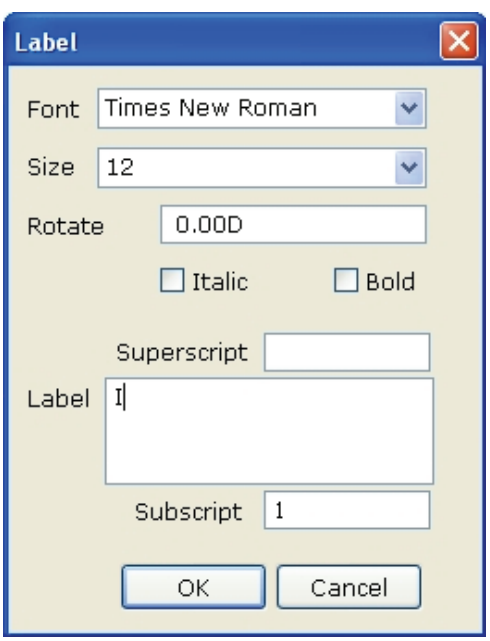
key, click successively on the four points in the order you want the labels to be completed and click on the "_Label Object " tool. Then the four points are automatically labeled B, C, D and E.

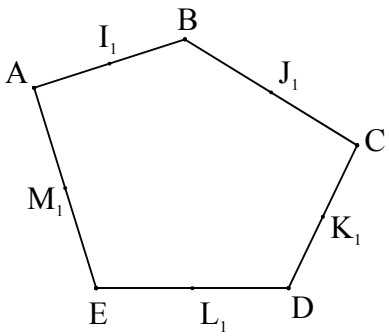
iii. As the continuous is still active, click in geometry toolbar on the line tool and move the pointer to the work sheet that turns into pencil form. Then, first move the pointer near the first point; when a red cross appears, hold down the left button of the mouse and slide the pointer towards the second point and release the left button as soon as a red cross appears at the second point. As the continuous mode is active, the pointer turns again into a pencil form to take a similar action. Then join in the same two other points and so on, At the end of this task, deactivate the continuous mode (just click again in drawing toolbar on continuous mode button)

iv. To relocate any drawn point, first you have to select it, Hold down the left button of the mouse and drag it to the desired position. You can also select the point you want to relocate and use anyone of the four arrow keys of the keyboard to move it.

v. This is just to a way to draw the middle point of a segment; the following example will show another way to carry out this kind of task faster.

vi. Select the middle point of AB segment (just click on this middle point). Then click on the "_Label Object " tool. Type 'I' in the Label case and '1' in subscript case as shown below. Click Ok to get 'I_1'.





Here too, you can label at once all the four other middle points. To do so, hold down the Shift key, click successively on these four middle points in the order you want the labels to be completed and click on the "_Label Object " tool. Then the four points are automatically labeled J_1, K_1, L_1. M_1.

Exercise 2

i. Click now from the task pane in Plane Geometry menu of Science graphics on common polygon icon "". Then draw five sides polygon.

ii. Label the vertices A_2, B_2, C_2, D_2, E_2. in a well ordered direction.

iii. Activate continuous mode, click on " Draw point tool" and draw directly the middle point of each side of the polygon. and label them I_2 J_2, K_2, M_2, L_2.

iv. Now deactivate the continuous mode and click on the side on side A_2B_2 and tell what is selected. Can you justify? How do you select the side A_2B_2?

v. Now select the two lines (A_2B_2) and (C_2D_2) and draw their intersection point.

vi. Draw I_2J_2 and K_2M_2 segments. Select them and find the ratio $\frac{I_2J_2}{K_2M_2}$.

vii. Can you use different way to select I_2J_2 and K_2M_2 segments? Justify !

Solution

i. When you click on the icon"", a dialog box appears with an option of 6 sides. Just replace 6 with 5 and click the button OK. As the pointer turns into a pencil, hold down the left button of the mouse and drag it appropriately; then release the mouse button. You can later select any vertex of this polygon and shift it exactly as it has been done in exercise1.

ii. First label one vertex A_2 and then label at once the other vertices.

iii. When you click in geometry toolbar on " Draw point" tool, just move the pointer to the middle of any side of the polygon. When you are close to the middle of this side, a tip displays clearly "Segment middle point". Then you just have to click. As the continuous mode is active, you can repeat the action to draw the middle points of the other sides.

iv. When you click on the side A_2B_2, the polygon $A_2B_2C_2D_2E_2$ is selected. This polygon is a geometrical object and its selection follows as well "the principles of selection" as described in the manual "Basic notions on drawings and geometry dynamic constructions",

The side A_2B_2 is not a point and it is an element of the geometrical object $A_2,B_2C_2D_2E_2$. To select solely A_2B_2 side, hold down Ctrl key, then click on this side.

v. This is a case of a series of selections of elements,. So hold down the two keys Ctrl and Shift of the keyboard and click successively on the two sides A_2B_2 and C_2D_2 to select them. When this is done, click on the intersection tool that is automatically available in geometry toolbar task zone, then the intersection point of the two lines (A_2B_2) and (C_2D_2) is automatically drawn.

vi. I_2J_2 and K_2M_2 segments are drawn as in exercise1. They are not elements of any object drawn. You can just hold down Shift key to select in this order I_2J_2 sand K_2M_2 segments. Then click on ratio tool that is automatically available in geometry toolbar task zone. The ratio is then displayed on the screen; the variation of this ratio follows the variation of the lengths of I_2J_2 and K_2M_2 segments.

vii. Yes! you can hold down Ctrl key to select the first segment, Ctrl and Shift keys to select the second.

You can also hold down the two keys Ctrl and Shift to select the two segments.

b) Simplified statement of objects selection principles

A block polygon is the ordinary or regular one you get when you click on or icon.

During a single selection

To select a single object that is not a side of a block- polygon or a coordinates axis, just click on this object.

To select a point, a single side of a block-polygon or a coordinates axis, hold down Ctrl key and click on it.

During a series of selections

To select any abject that is not a side of a block- polygon, hold down shift key when clicking on this object.

To select a side of a polygon or a coordinates axis, hold down the two keys Ctrl and Shift, then click on this side.

c) Dealing with lines

<u>Exercice3</u>

i. Draw a line (AB).

ii. Draw from a point E of (AB) a perpendicular line (EC).

iii. Draw from point C a parallel line (CD) to (AB).

iv. Draw the segment $[ED]$ and an extension line (DH) of this segment..

v. Draw segment CH and the bisector line (CI) of the angle $\widehat{HCD}$,

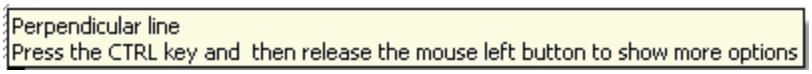
vi. Now we are considering the following modifications: $EC = 3cm$; $CD = 3cm$; $DH = 4cm$.

vii. What's the angle value in radians of $\widehat{HCI}$?

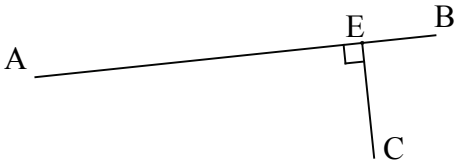
<u>Solution</u>

i. Click in geometry toolbar on the icon to draw a line and label the two ends A and B

ii. Click in geometry toolbar on the icon and move directly the pointer to the line (AB) that turns into blue color. Simultaneously a red cross and a tip "Link to the segment" appear. Then, hold down the left button of the mouse and drag the pointer towards a perpendicular direction to (AB). The following tip is displayed and means that you are drawing a perpendicular line or if not press Ctrl key and release the mouse left button to access more options.



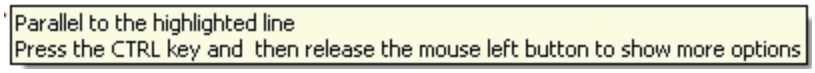
But as you aim to draw a perpendicular line, there is no need to press Ctrl key; just release the left button of the mouse. Label the foot E of the perpendicuar and the end C.



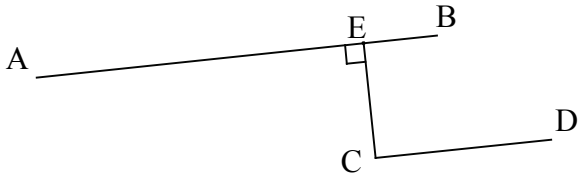
You can later select the point C and shift it with the help of the mouse to a desired position..

iii. First select AB segment (just click on it), then click in geometry toolbar on the icon . Move the pointer to C point (a red cross appears), then hold down the left button of the mouse and draw a line towards a parallel direction of (AB). When you are in this parallel direction, the line (AB) turns into blue color and you can see the following

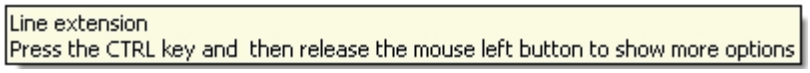
message.



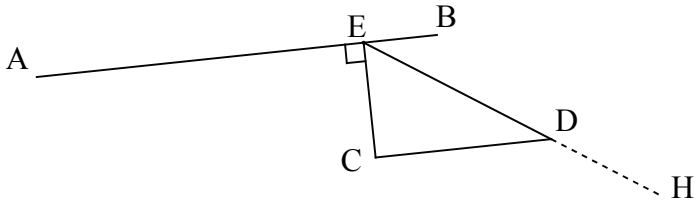
Here too, there is no need to press Ctrl key; just release the left button of the mouse. Label the end of this new line D.



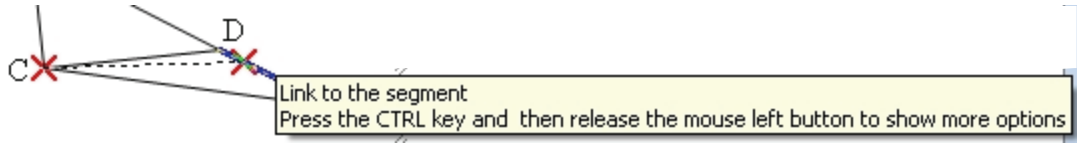
iv. Now activate the continuous mode and click in geometry toolbar on the icon . Join E and D points; As the continuous mode is active, move the pointer to the point D and when a red cross appears, hold down the left button of the mouse and draw (through the ED direction) an extension line of ED segment. When the following tip is displayed you can release the left button of the mouse



Right click (press the right button of the mouse) to end the action of drawing line and label H point. (Do not deactivate the continuous mode!)



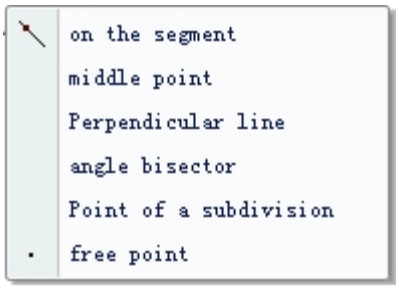
v. As the continuous mode is still active, click again in geometry toolbar on the icon to pursue the action of drawing line. Join points C and H.. Then move the pointer to the point C and when the red cross appears, hold down the left button of the mouse and move the pointer to a point of] DH] segment. Let see in the illustration below, the tip that appears.



As the first option shown here is "link to the segment" (not bisector) , then you have to

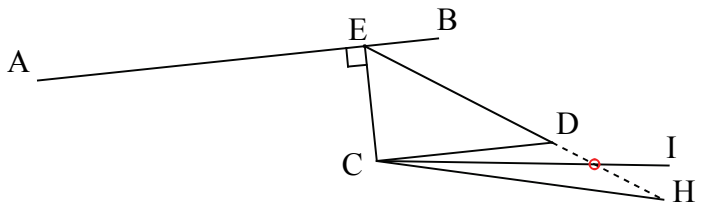
choose the second option that is:

Press Ctrl key and release the mouse left button. Then the following menu is displayed



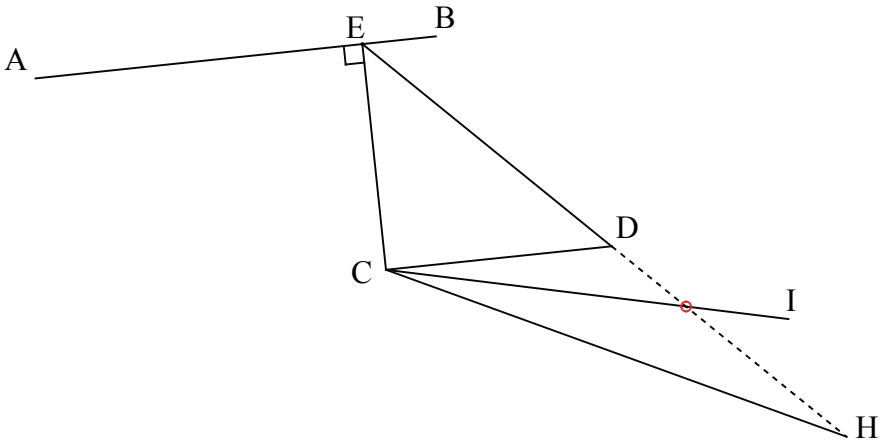
Just click in this menu on angle bisector. The result shows a bisector line and a red point This red point is the intersection point of the bisector line and the opposite side DH of the vertex C (in HCD triangle) .

Label point I. You can select I point and shift it at a desired position as shown in the figure below



vi. The modifications of the lengths of the segments can be done in object properties dialog box. You can double- click on a segment to access directly its object properties dialog box or right-click on it to get the contextual menu where you have to click on "Properties".

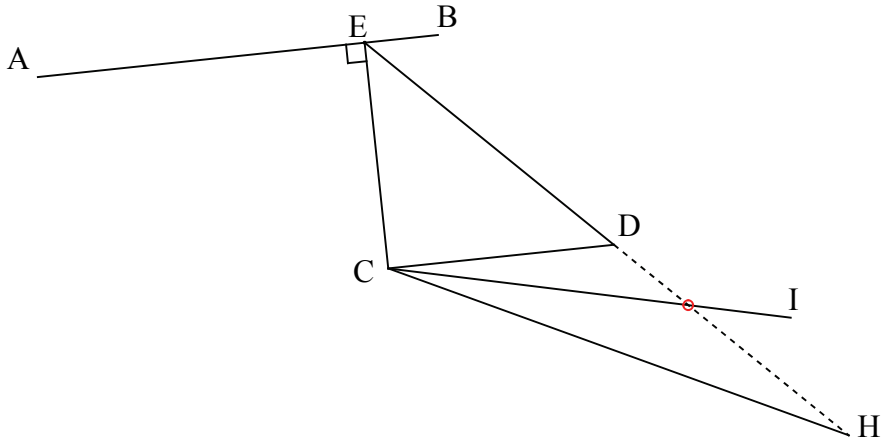
Click in this dialog box on "Size" and carry out the appropriate modifications as follow: EC = 30 mm; CD = 30mm; DH = 40mm.



vii. Select in this order points H, C and I. Then click on angle measure button that is

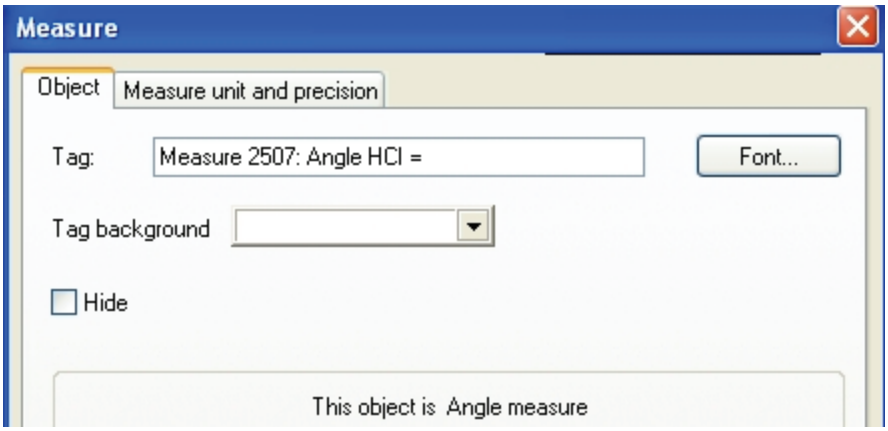
automatically available in Geometry toolbar task zone. The result of this measure is automatically displayed as follows

Measure 2507: Angle HCI = 12.93°

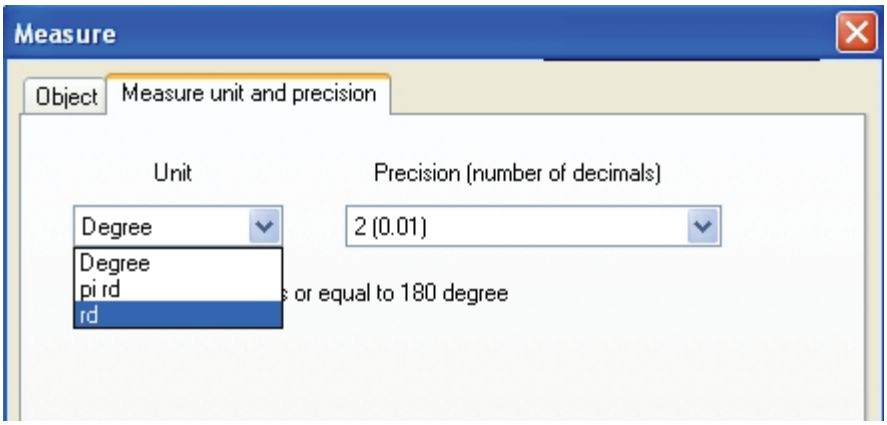


The measure is displayed as default in degree.

To convert it in radian, double-click on it to access its properties dialog box.



Select Measure unit and precision and select as shown below the rd unit.



Click on OK button to get the result as shown below.

Measure 2507: Angle HCI = 0.23rad

Exercise 4

i. Draw a circle centered at a point O_1 and having a 2cm radius.

ii. Draw a point O_2 at a distance 3cm of O_1.

iii. Draw the circle centered at O_2.and passing O_1..

iv. Draw the two intersection points A and B of the two circles.

v. Draw the angle bisectors (L_1) and (L_2) of the angles $\angle ABO_1$ and $\angle ABO_2$.

vi. Draw the bisector (L) of the angle defined by (L_1) and (L_2).

vii. Draw the common tangents to the two circles.

Solution

i. Click in geometry toolbar on the circle icon. and move the pointer to the worksheet that turns into a pencil. form Then hold down the left key of the mouse and drag the pointer to get a desired radius of the circle. Label the center O_1 of this circle. Go to the object properties of the circle and click on Size option to set the right radius of 20mm

ii. Click in geometry toolbar on the icon and move the pointer to O_1 point. As a red cross appears, hold down the left button of the mouse and drag the pointer to any location to get a segment drawn. Then go to the object properties of the dialog box of this segment to set the size of 30mm.

iii. Click in geometry toolbar on the circle icon. and move the pointer from O_2 to O_1 when making sure a red cross appears at the levels of O_2 and O_1.

iv. Click on point tool in geometry toolbar, activate the continuous mode and move the pointer to the level of each intersection point. When the tip Intersection point of two circles appears, just click to get the intersection point Label the intersection points A and B..

v. Select in this order A, B, O_1 and click in geometry toolbar task zone on angle bisector icon to get the bisector line. Select the line and click on Super Label icon . Then in the text zone that is automatically available, write (L_1). Select in this order A, B, O_2 to draw the second bisector and label (L_2).with the help of super Label.

vi. As the lines (L_1) and (L_2) have a common origin point B, just select these two lines. Then the icon of angle bissector icon becomes available in geometry toolbar task zone. Click that icon to get the result

vii. Click in geometry toolbar on the icon and move the pointer to one. A red cross appears at the level of each circle and the following tip pops up

Link to the circle
Press the CTRL key and then release the mouse left button to show more options

Then press Ctrl key and release the left button of the mouse to see more options as shown below in Fig1.

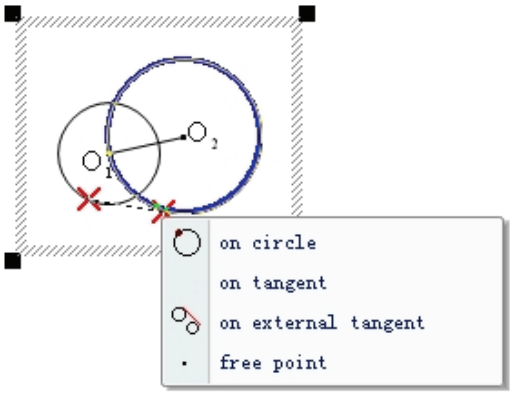


Fig 1

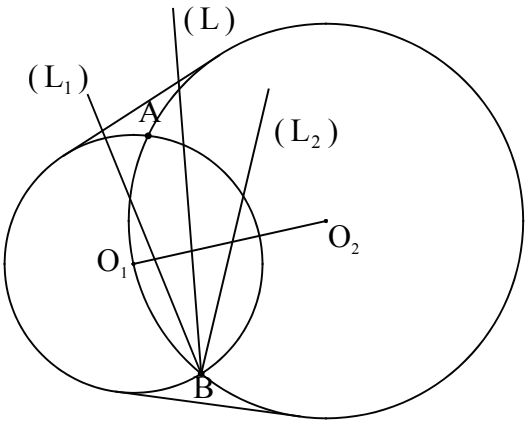


Fig 2

Click on External tangent to get the final result that is Fig2.

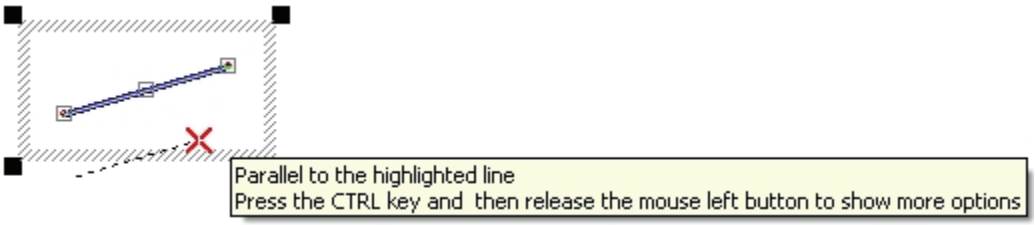
d) General aspect of drawing in natural way

d-1. On drawing point

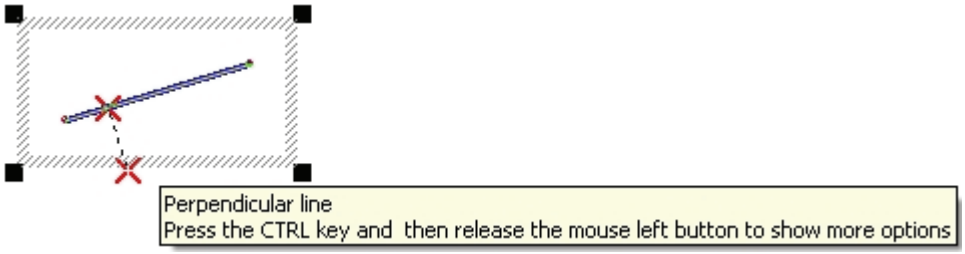
You can click in geometry toolbar on " Draw point" tool to draw a point in an empty space or select a point from segments-lines, triangles or polygon sides, circles, ellipses or any polyhedra (prism, sphere, etc) line or to draw the intersection point of lines and circles.

d-2. On lines

You can click in geometry toolbar on " Draw line" tool draw a line in an empty space or (from an empty space or a point) to link points, segments- lines, triangles or polygones sides, circles, ellipses or any polyhedra (prism, sphere, etc) lines . We are giving as follows, some illustrations.



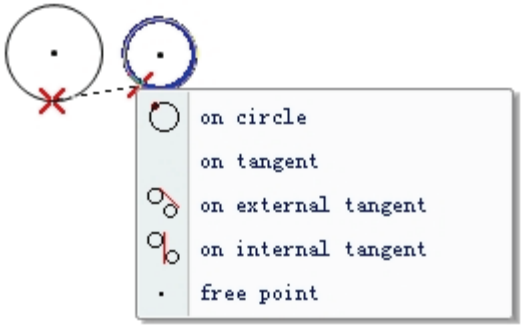
From empty space towards a direction of a selected line



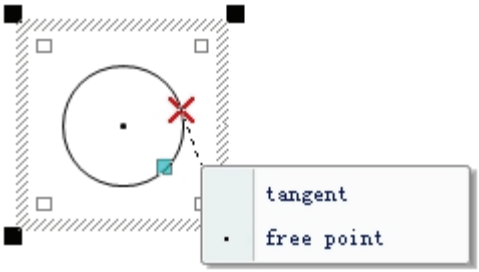
From a segment point towards a perpendicular direction of this segment

From a point to a circle

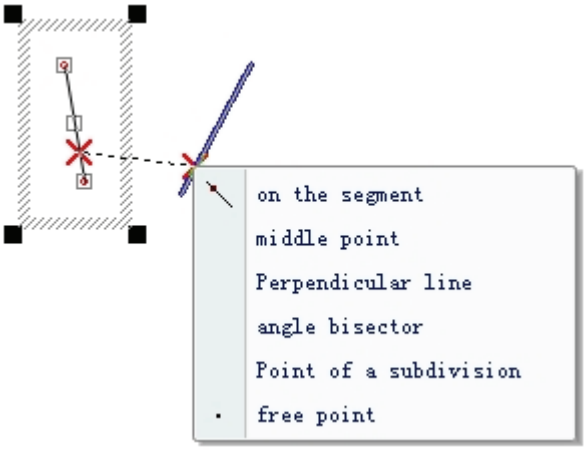
From an empty space to an ellipsse



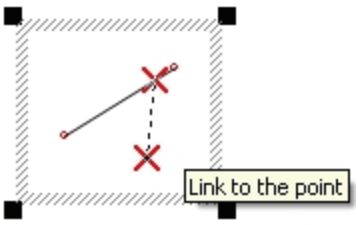
Circle point to circle point



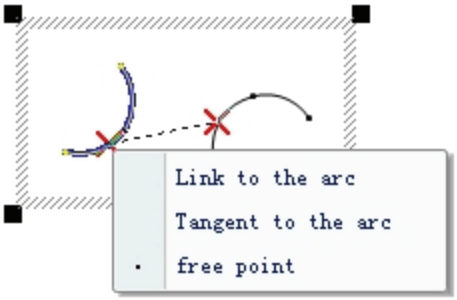
From a circle to an empty space



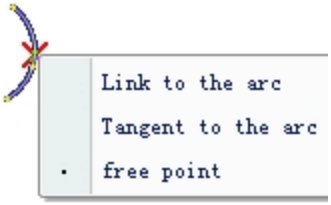
From a segment point to a segment



From a segment point to a point



Arc point to arc point

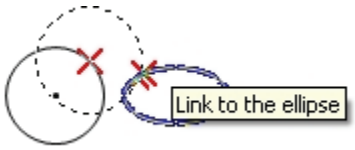


Empty space to arc

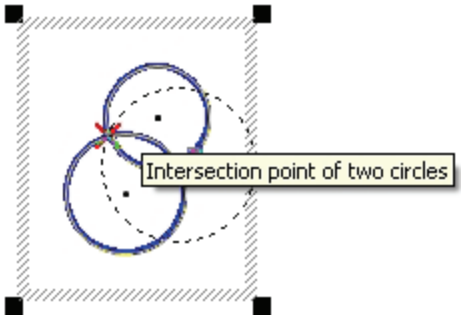
Arc to empty space

d-3. On circles

You can click in geometry toolbar on " Draw Circle" tool to draw a circle centered at a given point A and passing by any other point B. Points A and B could be newly created in an empty space or a point given point or a point of a segment- line, a triangle or polygon side, a circle, an ellipse or any polyhedral (prism, sphere, etc) line point. We are giving as follow some illustrations.



Circle centered at a circle point and passing an ellipse point

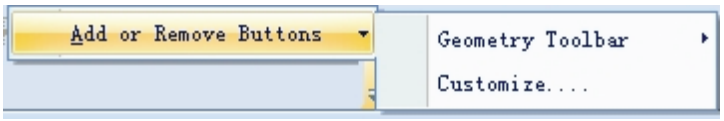


Circle centered to an intersection point and passing other intersection point

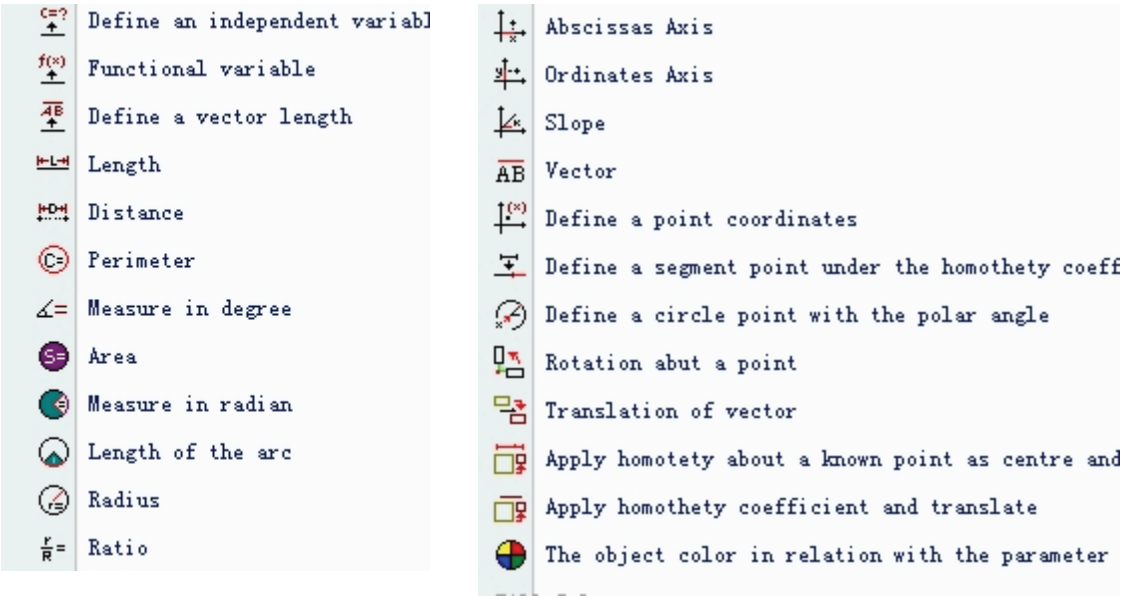
4) Drawing based on objects selection

Most of the tools but very powerful that are expected to be used in drawings have to be found in one location: that is the geometry toolbar task zone! But the corresponding objects to which these tools may be applied to, have to be drawn and to be selected! That's all! This is a new concept that simplifies totally the drawing! A big revolution!

To see all these tools, click on the end button of the geometry toolbar; then click on "Add or Remove Buttons" and then click on "geometry toolbar."



Then a list of more than 120 functions appears whereas the following is just a few part of these functions! It is very important for the user to be aware of these functions!



The complete list can be found in the book "Basic notions of drawing and dynamic constructions"

a) Principles of manipulation of the tools of geometry toolbar tasks zone

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

Then,

- Either a result is obtained immediately; this is the case for example with the inscribed circle of a triangle.
- Or a dialogue box appears and you simply type simple text; this is the case for example in **"Label Object "** (A).
- 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.

The user is supposed now to be able to locate the icons of basic geometry objects and draw or select point, line, circle, ellipse, angle, triangle, rectangle, common polygon, right

polygon, free-hand drawing curve, Bezier curve, Bezier vector,

b) The importance of object properties and motion properties dialog boxes

Some modifications of an object on line style, size data and other measures are carried out in properties or motion properties dialog box. To access an object properties or motion properties dialog box, right click on it and click on the contextual menu that opens up. You can also double-click on an object to access directly its properties or motion properties dialog box. All objects have properties dialog box; but not all objects have motion properties dialog box.

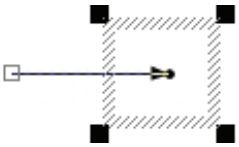
c) Examples of tools corresponding to a single object selection and their manipulation

c-1) Point

When a point is drawn (but under selection) the following are three of the tools that appear in geometry toolbar tasks zone..

- The connecting point icon " " appears always when an object is selected. It helps to create a point that moves with the object. To draw a connecting point, just click on that icon and click on the worksheet.

- To create an arrow at the drawn point level, just click the tool , An arrow appears as the figure below shows.



Get hold of the arrow by the left end to adjust it in the right direction. You can go through arrow properties dialog box to modify its color, size and style.

- To draw a ray having the point drawn as origin, just click on the icon . Then move the pointer to the worksheet and click at an appropriate distance of the point.. You can later, if needed the end of this ray.

- To draw centered at the point circle, just click on the the tool and click at an appropriate distance of this point. You can later, if needed stretch it or enlarge it through the manipulation of one of the four white squares surrounding it when selected. You can also modify the radius of this circle accurately through its properties dialog box.

c-2) Regular polygon

Click now from the task pane in Plane Geometry menu of Science graphics on regular polygon icon " ". In the dialog box that opens up, customize 9 sides and click OK. As the pointer turns into a pencil form, hold down the left button of the mouse drag the pointer appropriately.

Click on the icon " Draw circumscribed circle of the regular polygon" to draw a circle passing the vertice of this polygon. The result as you will notice is automatic. Yes, because there is not other choice to complete this circle.

You can select again the polygon to draw the inscribed circle, to display its area, etc. In fact you need to look at in the geometry toolbar task zone every time that the polygon is selected.

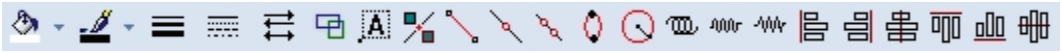
c-3) Bezier curve with arrow

Click on Draw button at the left corner of geometry toolbar, then in the menu that opens, select Plane Geometry Graph and click on the icon . to draw Bezier curve with arrow. Go through its propertied dialog box to reverse the direction of the middle arrow as shown below.

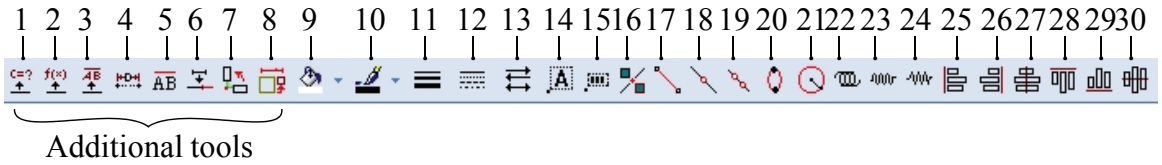
d) Examples of tools corresponding to two or more objects selection and their manipulation

d-1) Two points

Draw in this order two points A and B and select them. When they are not in the same drawing regions the following tools appear in geometry toolbar task zone as shown below



Click on " combine" to merge their drawing regions. Then you can see the same tools appearing with and an additional ones as follow



These additional tools (1 to 8) corresponding to the points selected are::

- ✓ Tool used to define variables (1- Define independent variable; 2-Define functional variable) ;.

- ✓ Tool to help to define to define geometric transformation (3 -Define vector through length and direction (numerical data) ; 5-Define vector through two drawn points (geometrical orientation and distance) ;.
- ✓ Tool to provide numerical data (4-Display the distance between two points or a point to a line) ;
- ✓ Tool to define a point through numerical data (6-Define through segments ratio a point on the line defined by two selected points)
- ✓ Geometry transformations (7-Rotation of objects defined by the last point selected as center and a given angle; Homothetic of objects defined by the last point selected as center and a given ratio)

These tools play an important role in dynamic geometrical constructions. That why they are called geometry animation tools.

You can pose momentarily the pointer of the mouse on a tool to see a tip that tells you the function it executes. We are giving through practical a description of some of them. The user may try the others.

i) Locating a point C of a segment AB using tool

We would like to locate a point C 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 $m = 2$, $n = 5$.

Click on the tool 19 . Then the dialogue in Fig1 appears as default.

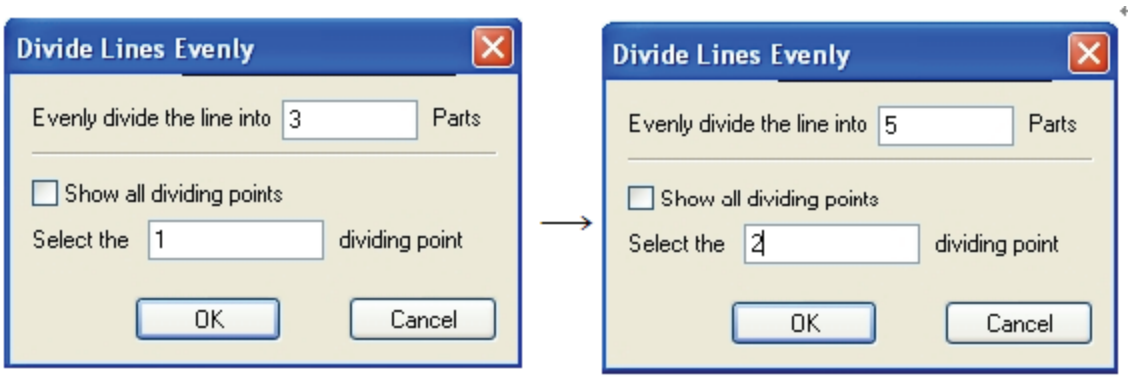


Fig1 Fig2

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

Fig3

<u>Note</u>: If you check "Show all dividing points", then you will get four points that insure

the subdivision of AB segment in five equal parts.

ii) Link A and B with a segment or a spring

To link the two points with a segment, just click on the icon 17 (Fig4) ; to link them with a spring click on one of the icons 22. (see Fig5) , 23 or 24)

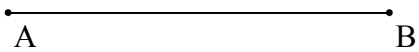


Fig 4

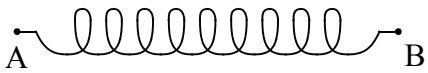


Fig 5

When the spring in Fig5 is selected, one of the end appears with four black squares . You can increase the number of spires by stretching horizontally this part of the set of four black squares (Fig6) . You increase the height by enlarging vertically the set of four black squares. (Fig7)

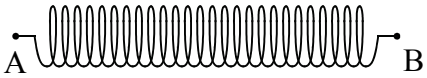


Fig 6

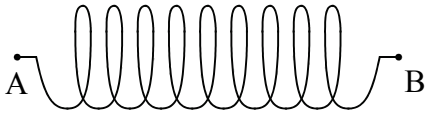


Fig7

iii) Draw circle , ellipse and symmetrical point

To draw a circle having its center at A and passing point B, just click on the icon 21 .

To draw a flexible ellipse passing A and B, just click on the icon 20 .

To draw the symmetry of point A with respect of the point B, just click on 16 - icon.

iv) Rotate A about B

You can click on icon 7 to get the rotation of point A about point B.

v) Define a vector $\overrightarrow{AB}$

You can define a vector by clicking on the icon 5 . Then later when you select any object of the drawing zone, the translation tool becomes available and you click to translate that object..

d-2) A point and a line

Draw a point P and a line (L) and select them.

- When A and L are not belonging the same drawing zone, the following tools become available in geometry toolbar task zone.

- When they belong to the same drawing zone there are the following additional tools.

- ✓ You can click on the icon to get symmetric of the line with respect to the point A (if the point A is the last selected object) or the symmetric of the point across the line (L) (if the line (L) is the last selected object) . Here the order of selection is important.
- ✓ You can click on the icon to get the parallel line to (L) line passing A point. Here the order of selection has no importance
- ✓ You can click on the icon to get the perpendicular to line (L) passing point A. Here the order of selection has no importance.
- ✓ When A and (L) belong the same drawing region, you can click on the icon to get the distance from point A to line (L) . Here too the order of selection has no importance

d-3) Three points

Draw three points A_1, A_2, A_3. and select them.

- When any two of these points are not belonging the same drawing zone, the following tools become available in geometry toolbar task zone.

- When they belong to the same drawing region there are the following additional tools

You may notice that all the alignment tools that appear when two points are selected are also available with two additional uniformly distributed alignment tools .

- ✓ You can click to get the bissector line of one of the three angles defined by these three points, whereas the order of selection is important.
- ✓ You can click to get the inscribed circle to a polygon having as vertices these three points.
- ✓ You can click to get the circumscribed circle to a polygon having as vertices these three points.
- ✓ You can click to get one of the three arcs passing these points whereas the order of selection is important.

- ✓ You can click to get label arc of one of the three angles defined by these points whereas the order of selection is important.
- ✓ You can make it selectable the polygonal region defined by these three points and fill it with the tool
- ✓ You can get the measure of one of the three angles defined by these points with the tool ., whereas the order of selection is important.
- ✓ You can get the area of the polygonal region defined by these three points when clicking on the tool .
- ✓ You can get the rotation of the two first points selected about the third one when clicking on tool. The order of the selection is then important.
- ✓ You can apply the homothetic having the third point selected as center to the two first points selected with the toll . The order of the selection is then important.

III) Drawing of some usual geometrical figures

1) Dihedral angle

i) From task pane, in "Plane Geometry" click on button to draw a parallelogram ABCD (Fig1)

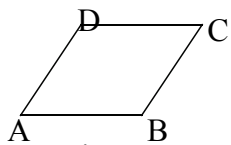


Fig 1

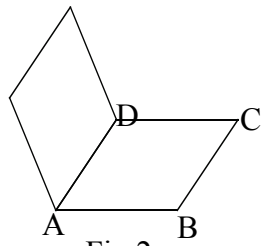
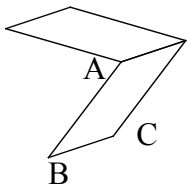
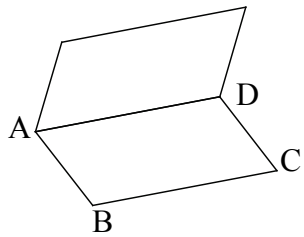


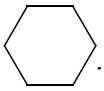
Fig 2

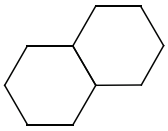
ii) Select in this sequence the parallelogram and its side AD, then in the geometry toolbar task zone click on the tool - in order to draw the symmetric of this parallelogram across (AB) side (Fig2) . You can subject ABCD parallelogram to a rotation or stretch it through one of its vertices to get the following figures..

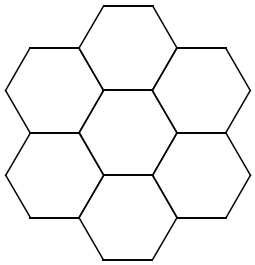


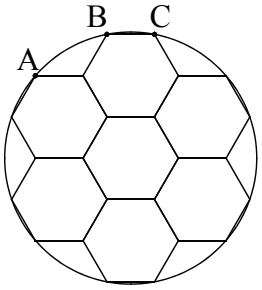


2) A ballon

i) Draw a regular hexagon (click on " Regular Polygon" icon)  .

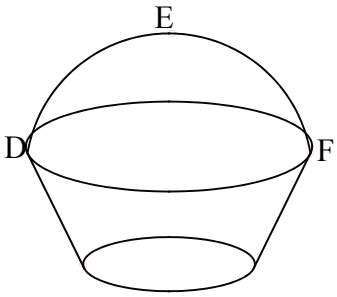
ii) Draw the symmetric of the hexagon across a side (select the polygon and a side on - tool in the task zone of geometry toolbar) 

iii) Draw in the same way the symmetric of the hexagon across each other side. Then you obtain the following result: 

iv) Select three **non common** vertices A, B, C of two polygons then click on icon to obtain the balloon: 

.

3) A bucket



Draw an ellipse and click on " Create Similar object" tool to draw a similar ellipse. Select the two ellipses then click on tool to align vertically their centers then click on " Draw line tangent. . . " tool to produce the tangents common to the two ellipsis. Click thereafter on " Connecting Point " tool that appears in the Geometry Toolbar to draw a connecting point above the big ellipse. Select in this order the left end D of the ellipse, the connecting point E and the right end F of the ellipse. Then click on " Arc " tool and click at the level of the connecting point E to produce the arc.

4) A cogwheel

Draw a rectangle ABCD and the perpendicular (IJ) to AB segment in its middle point I

Rotate rectangle ABCD about I point and take successively the angle values: 60°, 120°, 180°, 240°, 300°. (Fig 2) .

Draw the circle centered in point I and passing by point C. Then fill the rectangle with white color and non transparent option. Finally add white color to (IJ) line, DC segment and perpendicular foot angle and hide labels A, B, C, D, I, J (Fig3) .

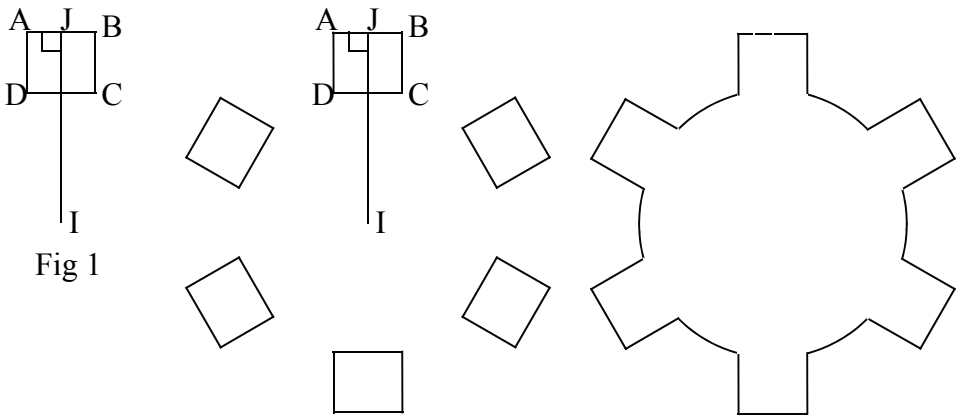
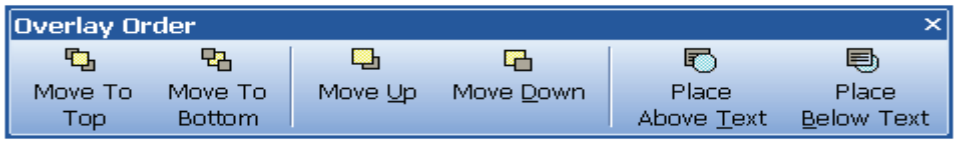


Fig 1 Fig 2 Fig 3

IV) Order of superposition of objects

1) Overlay Order

ScienceWord has a menu of functions (**Overlay Order**) , which facilitates the arrangement (one on top of the other) of objects among themselves or of an object and a text (see the illustration below) .



The effect of these functions is visible only in non- transparent objects (see the figure below)

Superposed non-transparent objects Superposed transparent objects

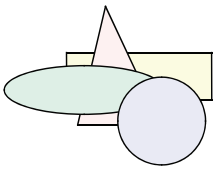
In ScienceWord however, every object that can be filled appears transparent by default . In fact, in the "**Fill**" sub- menu of "**Object Properties**" of such an object, the "Transparent" option appears by default as the following image shows " Transparent ".

This object can thus be made non- transparent by deactivating this option (just click on this option) .

<u>Application Example</u>

Draw successively in this sequence; a rectangle, a triangle, an ellipse and a circle, all being non-transparent and colored as they appear below. Deactivate the "Transparent" option within the properties (**"Properties"**) of each object.

Let us remember the procedure for going to the properties of an object; select it, make a right- click, then click on **"Properties "** in the contextual menu which pops up.

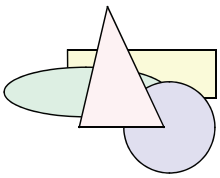


To illustrate the functions of " **Overlay Order** " better, we shall apply the following four options exclusively on the triangle of the group of objects below:

"**Move To Top**"

- Click on the triangle to select it;
- Make a right-click of mouse to reach the contextual menu;
- Click on "Overlay Order" in the contextual menu to reach the " **Overlay Order** " option;
- Click on "**Move To Top**"

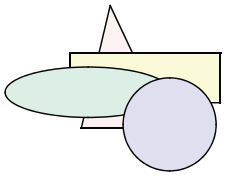
The triangle appears on top of all the objects as the figure below shows



The triangle is placed on top of the other objects

" **Move To Bottom**"

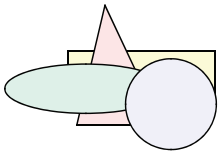
Follow the same procedure as above to enter into the options of " **Overlay Order** " and then click on " **Move To Bottom**".



The triangle is placed under the other objects

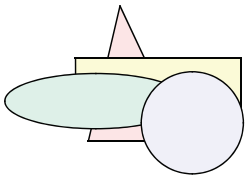
"**Move up**"

Follow the previous procedure shown for entering the option of " **Overlay Order** ", then click on "**Move up**".



"**Move down**"

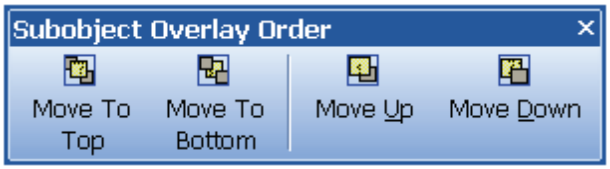
Follow the previous procedure shown for entering the option of " **Overlay Order** ", then click on "**Move down**"



<u>Remark</u>: The objects to which the options of "Overlay Order" are applied do not have a common selection region.

2) Subobject Overlay Order

The function "**Subobject Overlay Order**" is objects superposition function that enables the arrangement (one on top of the other) of objects of the same drawing region.



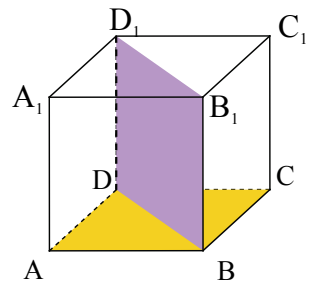
The principle of application is the same as that of "**Overlay Order**". You could also reach the "**Subobject Overlay Order** " function by means of the contextual menu.

3) Note on objects superposition:

When two objects are drawn one after the other, the second object drawn is as default superinposed above the first one.

Example 1

Let complete the opposite cube.



Click from Science Graphics in "Solid geometry" pane on the cube icon and move the pointer to the work page. As the pointer turns into a pencil form, just click at the desired location to get the cube drawn.

Select in this order points A, B, C, D and click on the "Select and fill polygonal region" icon available in geometry toolbar task zone. The region is automatically hatched as default. Then, click in in geometry toolbar task zone on fill color icon to select yellow color. Do the same with D, D_1, B_1, B points and go it object filled region properties to uncheck "Transparent" option.

Example 2

Draw a rectangle and select two points A and B on one side as shown opposite (Fig 1) .

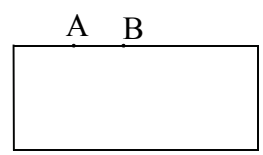


Fig 1

Now we are going to create a hole on this rectangle, exactly at the level of AB segment.

Select points A and B and click on line segment icon immediately available in geometry toolbar task zone.. As soon as the two points A and B are linked with a new segment, just click on brush color icon and. select white color (Fig 2) .

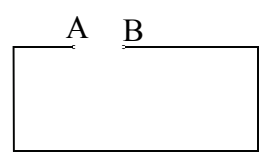
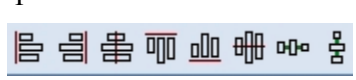


Fig 2

V) ALIGNING OBJECTS

1) General view

During the creation of drawings, it often happens that a need arises for objects to be aligned according to a certain harmony and a precise order. To fill this need, ScienceWord offers the following alignment options:



To carry out the alignment, first select the object to be aligned. Immediately after the objects have been selected, the range of alignment options would appear in the geometry toolbar. Just click then on the option desired.

The act of alignment is done by means of a rectangle that demarcates the selection region of the object; the first object selected serves as the basis of the alignment.

The "***Object Group***" button helps to align the left ends of the objects selected. (Fig1) ; the "***Object Group***" button helps to align the right ends of the objects selected. (Fig2) ; the "***Object group***" button helps to align vertically the centers of the rectangle limiting the objects selected (Fig 3) ; the "***Top Align Object Group***" button helps to align the top ends of the objects selected. (Fig4) ; the "***Object Group***" button helps to align the bottom ends of the objects (Fig 5) ; the "***Object Group***" button helps to align horizontally the centers of the rectangle limiting the objects selected (Fig 6) ; The ***"Object Group"*** helps to align vertically the centers of the rectangle limiting the objects (Fig7) ; the horizontal and vertical uniform distribution buttons help to keep equal distance between objects.

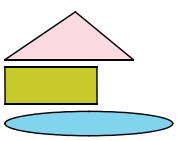


Fig1

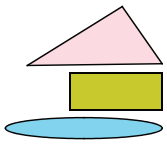


Fig 2

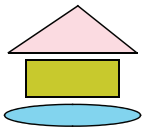


Fig 3

Fig 4

Fig 5

Fig 6

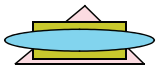


Fig 7

Remark:

i) Every object has four ends (left, right, top and bottom) . It is inscribed in a rectangle having as vertices the points of intersection of the vertical and horizontal lines containing its ends.

It can be verified that the alignment of the objects is done in relation to rectangles in which they are inscribed, the first object selected serving as the reference point of alignment.

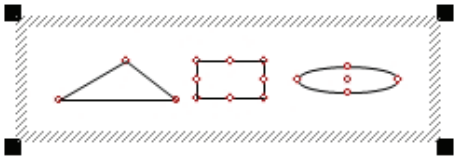
ii) The alignment will not be modified, if instead of selecting an object, one of its

elements is selected. For example, the same alignment would be obtained, if instead of selecting the triangle, a vertex is rather simply selected.
Thus, the selection of an element of the object entails the appearance of the triangle demarcating the selection region of the object. The alignment is done in relation to a rectangle as mentioned above.

2) The importance of the "Combine " tool

The direct application of the options of alignment does not allow the alignment of elements of a group of objects. The explanation on this is to be found in (ii) of the remark above.

When the function "*Combine* " applies to a selected group of objects, it helps demarcating a common selection region of the objects in question, destroying in this way all the individual selection regions of these objects (see the following illustration)



It is thus a type of partial grouping that makes possible the alignment of elements of these objects or the alignment of an element and an object in a well- defined location.

VI) Intersection: lines. curves, regions

1) Intersection: lines, curves, regions

To get the intersection point of two lines, just select them and click on the that is automatically available in the task zone of geometry toolbar.

To get the intersection points of line and circle or a line and ellipse or two circles, just select, just make the appropriate selection and click on the icon that is automatically available in the task zone of geometry toolbar.

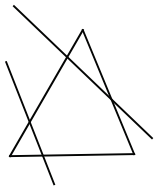
To get the intersection points of two selected ellipses of the same drawing region (if not, merge their region with " Combine" tool) , just click on the tool that is automatically available in the task zone of geometry toolbar.

To get the intersection of two regions, select them and click on the icon that is automatically available in the task zone of geometry toolbar.

1) Practical examples

Example1

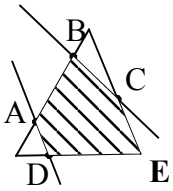
Hatch the domain limited by the triangle and the two lines.



Solution

Each line cross two sides of the triangle. Draw the intersection points A, B, C, D.

The domain limited by the triangle and the two lines A B C E D, where E point is a vertex of the triangle.



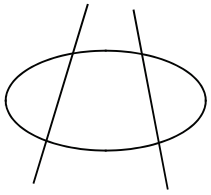
Now select in this order A, B, C, E, D and click on the icon " Select and Fill polygonal region" to fill the region.

In the following example2, we are describing a faster method.

Example2

Hatch the domain limited by the segments and the ellipse.

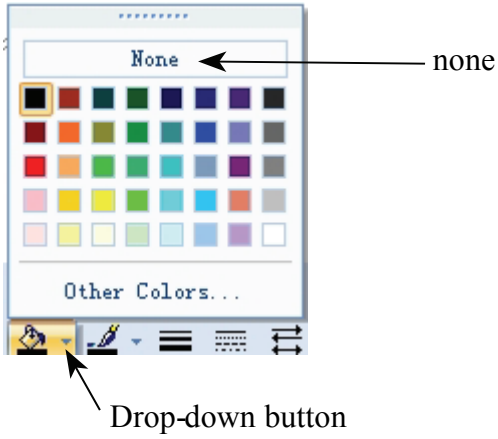
.



Solution

Select in the clockwise direction the ends of the two lines (in all four ends) and click on the icon " Select and Fill polygonal region". (Fig1) .

Then click on the drop-down button to open the color menu and click on "none" that means no fill (Fig2) . But the region remains selectable.



Select the region defined by the two segments (just click in this region) and click on the

ellipse. Then click on the icon " Select and fill region" (Fig 3)

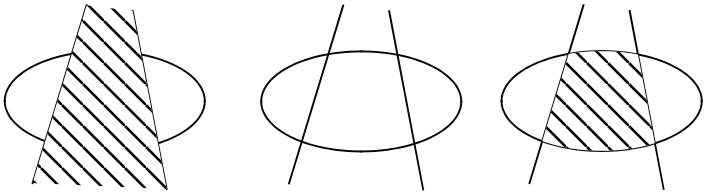


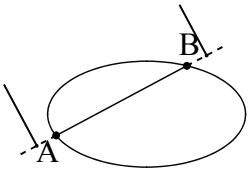
Fig 1 Fig 2 Fig 3

Example3

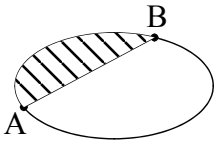
hatch the portion of ellipse demarcated by the small arc $\overset{\frown}{AB}$ and the chord [AB], and the portion of circle demarcated by the small arc $\overset{\frown}{CD}$ the chord [CD] (see in below) .

Solution

Hatching the portion of ellipse:

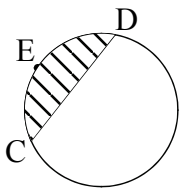


Draw the left and right extension lines of segment AB and draw a perpendicular to each extension line. Consider the four ends of the two perpendiculars and use the above method to get the result. At the end, you have to hide the extension and the perpendicular lines.



Hatching the portion of the circle:

Select a point of small portion of circle supported by the chord CD. Then select in this order points C , E, D and click in the task zone of geometry toolbar on the icon to draw the arc $\overset{\frown}{CD}$. Then click on the " " tool that appears in the Geometry Toolbar task zone to get automatically the result



Note:

You can get the same results with other methods. But here it is all about efficiency in specific circumstances.

For instance, you can use the techniques explained here to carry out more complex drawings.

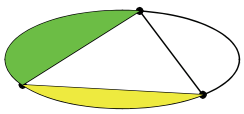


Fig 1

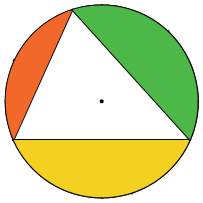


Fig 2

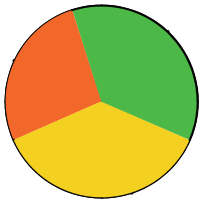


Fig 3

- To get an arc of circle filled as shown in Fig2, select this arc and click first on "
  Select and fill region" icon and then click on fill color icon
- To get an arc of circle filled as shown in Fig3, click directly on fill region" icon and then click on fill color icon .
- In general, you can access to an arc properties dialog box for options "Fill pie", "Fill bow", "display the arc center", etc.

VII) Geometry transformations and constructions animation

We consider few practical examples

<u>Example1</u>

Let consider a triangle ABC such that $\widehat{A} = 20°$, $AB = AC$, a point X of AB segment and a point Y of AC such that $A\widehat{C}X = 20°$, $A\widehat{B}Y = 30°$.

Find the measure of $C\widehat{X}Y$.

<u>Solution</u>

Firstly: Draw any segment AB. (Fig 1)

Secondly: Select in this order segment AB and point A. Then click on icon in geometry toolbar task zone to carry out the rotation of AB of 20° about A. (Fig 2)

Then: Carry out the rotation of BA segment of 30° about B, the rotation of CA of 20° about C. Draw the intersection points X and Y and find the measure of $C\widehat{X}Y$.

Measure 14137: Angle CXY = 30.0°

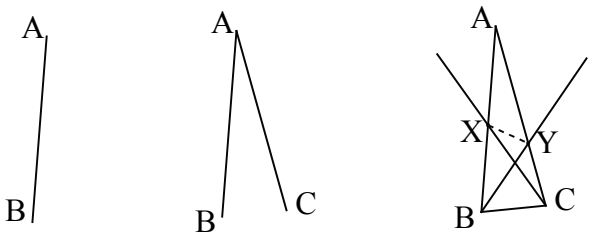


Fig 1 Fig 2 Fig 3

<u>Example2</u>

Draw an ellipse as shown opposite where point A and B are two vertices.

Draw point C of AB segment such that $AC = \frac{\sqrt{7}+3}{\sqrt{5}+5}AB$.

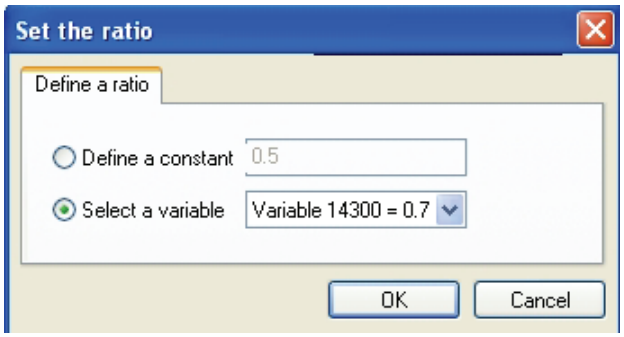
Define the vector $\overrightarrow{AC}$ and apply the translation of vector $\overrightarrow{AC}$ to the ellipse, and again to the new ellipse and again.

Solution

Make sure that the drawing region of the ellipse is selected, then click in the task zone of geometry toolbar on functional variable icon and write in the expression box (sqrt (7) +3) / (sqrt (5) +5) . Then select the precision 5 decimals and click on "OK" button to display the variable and its value on the worksheet.

Variable 14300 = 0.78022

Then select in this order A point and B point, then click on the icon " Define a segment point..". In the dialog box that opens up, check "Select variable" option as shown below.



Then click on OK button to get C point.

Define the vector $\overrightarrow{AC}$, then select the ellipse and apply the translation of $\overrightarrow{AC}$ vector.

Apply the same translation of a new ellipse drawn and repeat the action.

Vector14393: From A, to C
Variable 14388 = 0.78022

Example3

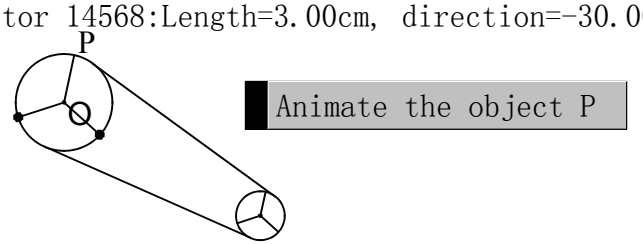
Draw a circle and click on the tool "Draw radius " that appears in Geometry toolbar to draw a radius OP of this circle. Apply to this radius two rotations of 120^0 and 240^0 about the center of the circle. Define a vector having as length 3cm with a direction of -30^0.

Select the circle and the three radius and apply homothetic and translation " where the homothetic coefficient is 0.5.

Draw the common tangent of the two circles and draw the segment that links the two centers as shown below.

Select P point and click from the sub-menu Control buttons of "insert" menu on animation button. The animation button that appears helps to animate P point and then the system.

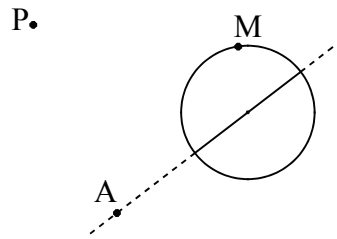
Vector 14568:Length=3.00cm, direction=-30.00°



.

Example 4: (Problems of trajectory)

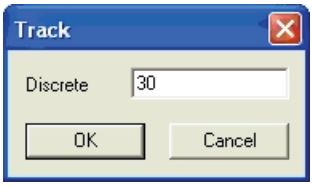
In a given plane we consider point A of an extension line of a diameter of C circle.. For any point M of C, we associate point P of the plane such that AMP triangle be equilateral. The vertices A, M, P taking in this order come one after the other in the trigonometric direction.

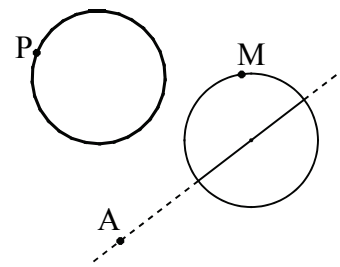


Select in the order point M, then point A, thereafter click on " Rotation around a point" tool. In the "Define angle" dialog box that opens, mark 60 as shown in the following illustration.

By clicking on OK button, you obtain a point P which is the solution of the problem enumerated.

- To get trajectory of point P directly, select in this order point M, then point P. In the animation toolbar click on "Display trajectory" tool. In the dialogue box that opens, the number that appears by default is 30.



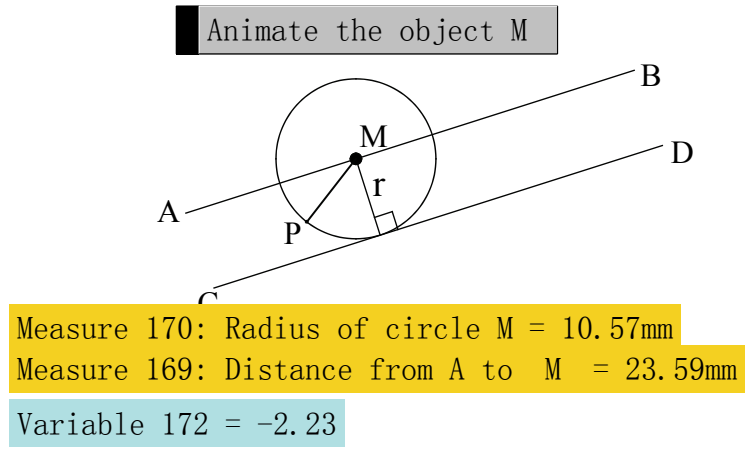


If you want to have a continuous trajectory, then write a bigger number in that box, for example 100.

<u>Example 5</u> (*Motion of bicycle wheel*)

Draw the following figure where (AB) and (CD) are two parallel lines, M a mobile point of the line (AC) and r the radius of the circle of centre M is tangent to (CD) line.

Let's draw a variable point P of the circle with polar angle $\theta = -\frac{AM}{r}$rd (this means that point P moves in a clockwise direction and the length of the arc traced by P is equal to AM distance).



To do this, select points A and M, then click on "Distance" tool to obtain the variable distance of A to M.

Equally, select the radius of the circle and click on "Length" tool to display the radius of the circle.

Define through "Define a functional variable" tool, the variable corresponding to

the polar angle θ as defined above. Select the circle, then click on "Draw a point of the circle" tool to draw point P. Finally join P and M.

To roll the wheel, select point M, then insert its animation button from "Insert menu" and click on it.

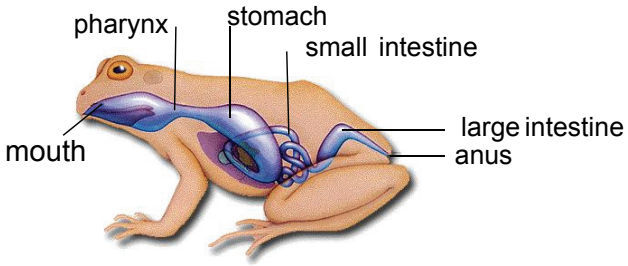
If you want the motion in both directions, select point M, then click on "Animation button" in "Insertion" menu. In motion properties of this button, select "Animation" tab, then click on the "Directon" drop-down button to select "Both directions" option.

VIII) Graphics Library

After creating a drawing or inserting a picture or writing mathematical formulae or chemical equation in a text box or drawing chemical object, it is possible to save them in the graphics library for later use.

1) Inserting a drawing into the graphics library

The following frog for example has been imported as image and labeled in ScienceWord. Now there is a need to save it in the graphics library or a later use.



Make a right-click with the mouse and click in the contextual menu that opens up on "Add to extended graphics".. A dialog box opens and you just need to choose a location and save the graphics as a "dsg" file.

2) Importing objects from graphics library

You can use the hotkey "Ctrl +L" to import directly from the previous location where graphics have been saved to. The pointer turns into a pencil and you just need to click at a desired location.

You can get it also from "Graphics Library" of the task pane. You will just need to hold down the "Ctrl" key and drag it into the worksheet at a desired location

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