GeoGebra Resources:
Polar Axes; Polar Coordinates

Using GeoGebra – Polar Axes,
Format Painting, Auxiliary Objects
Points with Cartesian/Polar Coordinates

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http://math247.jot.com

Key Concepts from GeoGebra

1. Starter File - Polar Axes
2. Format Painting
3. Auxiliary Objects
4. Points – Cartesian and Polar

Key Concepts from Mathematics

1. none

Our goal

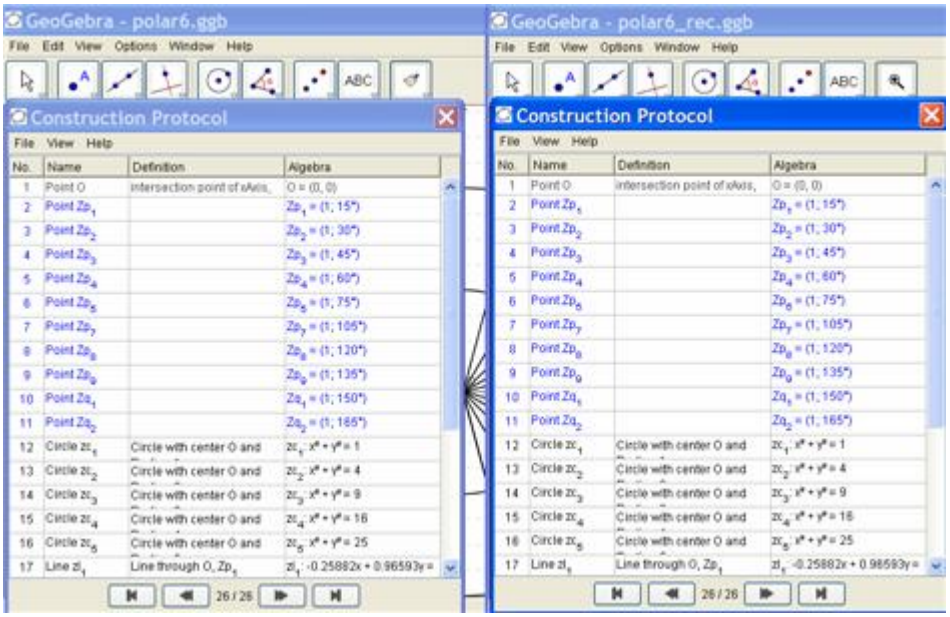
Open existing files, see construction protocol, use format painting, understand auxiliary objects and switch between cartesian and polar coordinates.

Hints & Tips

1. Cartesian coordinates are separated by a comma! A=(2,2)
2. Polar coordinates are separated by a semi-colon!
    i. A=(r;θ°) or A(r; θ) (if option is set to angles in radians).

Script-o-matic

1. Download and save the ggb files: polar6.ggb and polar6_rec.ggb
2. Double-click on each of these files to open them both in separate instances of GeoGebra.
3. What is an Auxiliary object?
   a. Look at polar6.ggb and then at polar6_rec.ggb
      - Both of these files have exactly the same objects.
      - But in the Algebra window in polar6_rec.ggb, we can only see the object point O at (0,0).
   b. Click View -> Construction Protocol in each file – the lists are exactly the same. In fact, polar6_rec.ggb is constructed from polar6.ggb.



      - Why aren't these objects listed in the algebra window of polar6_rec.ggb?
   c. Close the Construction Protocol in each file.
   d. In polar6_rec.ggb click View -> Auxiliary objects
      - You can now see all of the objects, that is
      - All of the objects were 'moved' to the Auxiliary objects folder and then this folder was 'hidden'.

The purpose of the Auxiliary Objects folder is to hide 'background' objects or objects that the user does not need to see or that will only obfuscate* the goal of the construction.

* Had to look up obfuscate myself – it means confuse, conceal, complicate – exactly right ☺.

Making Auxiliary objects.

- Since polar axes are certainly 'background', we consider these objects the ideal candidates for explaining auxiliary objects.
- First we decide what objects we will need.
- Then, when constructing we name all objects with names we won't need (or even think of using) in the 'real' construction.
  - Since you probably will use this 'starter' file more than once, it is a good idea to be organized – I only renamed and reorganized everything 4-5 times ☺.
- Then, when everything was constructed, they were moved to the Auxiliary objects folder.
  - Right-click on each object in the Algebra window and then select Auxiliary object.

If you rename, redefine or edit an Auxiliary object it will move back to its rightful place under free or dependent objects. Changing properties does NOT do this.

For example, I originally defined all of the points using cartesian coordinates (calculated with $\sin\theta$ and $\cos\theta$) and then understood that I could switch to polar coordinates. But the polar numbers weren't exactly right, so I edited which caused all the points to move back to free objects and I had to move them back to auxiliary again ☹.

- Then, before final save (or export) click on View -> Auxiliary objects to hide the folder and all of its objects

Let's start a new file and try this out.

4. Creating the point O(0,0).
   a. Double-click on your GeoGebra icon to get a new file
   b. Turn on the Algebra Window: View -> *Algebra Window* (or Ctrl+A)
   c. Turn on the Input field: View -> *Input field*
   d. Define the point O (capital O – not zero 0)
      - Click down in the input window and type O=(0,0). Notice that this is a free object. We do not want this[*].
      - Delete A by right-clicking on it and selecting delete.
   e. Now turn on the Axes: View -> *Axes*
      - Select the point icon  and then click on (0,0).
      - Notice that A=(0,0) is a dependent object, namely the intersection of the x-axis and y-axis. This is what we want.

[*] We can 'artificially' fix O by right-clicking, choosing properties and selecting Fix object. I don't like this because I forget and then the object appears to be free and when I can't move it, I get frustrated.

- Rename this point O (right-click and rename O).
- For fun, right-click on O and click on Polar Coordinates. Notice that O(0;180°).

There is a semi-colon between polar coordinates – that is between the radius and the angle; that is what tell us that we are using polar coordinates and not cartesian coordinates (comma). This is particularly important if we switch to radians, where there will NOT be a degree sign to give us a hint!

- Right-click on O and click on Cartesian Coordinates (notice that this is a toggle function, i.e. it alternates between polar and cartesian).

5. Draw a ray at 15° - or actually a line for both the rays 15° and 195°.
   a. Define the point with Zp_1 with polar coordinates (1; 15°) that is with a radius of 1 and angle measure 15°.
   - Click in the input window and type: Zp_1=(1;15
   - Then click on arrow to the right of the equal sign and select °.
   - Type) and hit Enter.

   b. Draw the line
   - Click on the line icon  and then click on O and then on Zp_1 (they will 'glow' when you hover over them…)
   - Right-click and rename this line zl_1 by typing: zl_1

   - We are using the GeoGebra convention that points start with capital letters and lines, circles, etc. start with small letters.
   - We could have input: zl_1 = Line[O, Z_1]. I find it easier to use icons and rename.

   but in both cases for sure you can do whatever you want ☺.

6. Draw a couple of circles
   a. Draw the circle of radius 1 through the point O and Zp_1.
   - Click on the circle-2pts icon  and then click on O and on Zp1.
   - Right-click and rename this circle zc_1 by typing: zc_1.

   b. Draw the circle of radius 2
   - Click on the circle-radius icon  and then click on O and then type in 2.
   - Right-click and rename this circle zc_2 by typing: zc_2.

7. Move everything except O to the Auxiliary objects folder.
   a. Right-click on each of Zp_1, zl_1, zc_1, and zc_2 and select Auxiliary object.
   b. The four objects will move down.

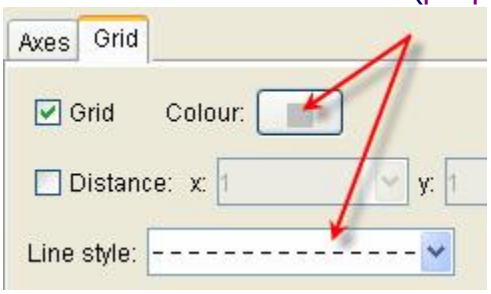
8. Hide the labels
   a. When hiding a bunch of objects:
   b. Click on the show-hide label icon  and then click on the objects in either the drawing pad or the algebra window.

9. Hide the point Zp_1
   a. Right-click on Zp_1 in the Algebra window (Don't click in the drawing pad – there are 3 objects in that place.)
      (BTW: I can't get the show-hide object icon  to work…)

10. Show the cartesian grid.
   a. Click on View -> Grid
   b. Look at the lines – we want that kind of lines on our polar grid.
      - Click on Options –> Drawing Pad
      - While we are here – let's turn off the numbering on the axes
      - 

        Deselect Numbers (red arrow) and then click on yAxis tab (blue arrow) and then deselect Numbers on this sheet.

      - Now click on the Grid tab (purple arrow)



        The color is grey RGB(192,192,192)* and the line style is mini-dashed. The line width is not given but it is 2 (default).

      - Click on apply.

11. Paint our polar grid.
   a. Set the properties on one of the objects.
      - Right-click on the line or one of the circles and select properties.

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* I personally want the cartesian graph slightly lighter than the polar graph so I move the color to RGB(220,220,220) - click on the gray square to open the color window and then select the RGB tab and move the sliders to the right.

- Set the color to grey, i.e. click on the grey square to open the color window and then either select a swatch or select the RGB tab and type in 192,192,192. Click on OK.
- Set the line style. Click on the arrow and select the mini-dashed style.
- Click on Apply.

b. Paint the rest of the objects.

- Click on the copy visual style icon  (a.k.a. paint icon)
- Click on the object on which you fixed the properties.
- Then, click one by one on the objects you wish to 'paint' with the same properties (sometimes it gets stuck and you have to start again...) .

12. Save or throw this file away as you desire and then alter the starter files to fit your needs! Don't forget to hide the auxiliary folder before exporting.