

In class we defined inversion of a point across a circle of radius ρ centered at the origin. The book has a piecewise definition in section § 7.2, and I gave you two alternate definitions as well. In this lab you'll construct the inversion of a point A across a circle, and illustrate the second of the three definitions:

Definition. Given $A \neq O$ and c , the circle of radius ρ centered at O , then $A' = \mathcal{I}(A)$, the inversion of A across c , is the point on ray \overrightarrow{OA} such that $|\overline{OA}| \cdot |\overline{OA'}| = \rho^2$.

You'll also use GeoGebra's ability to create text labels which automatically update when you change your diagram.

GEOGEBRA CONSTRUCTION

- (1) Open a new GeoGebra window. Go to the View menu and turn off **both** the axes and the grid, so the drawing pad is blank. I'd also recommend going to the Options menu, choose Labeling, and make sure "New Points Only" is selected to avoid having GeoGebra display a label for every single line segment you create.
- (2) Create a circle of radius $\rho = 2$ centered at the origin using any method. The simplest is to type $x^2 + y^2 = 4$ in the Input field. Pay attention to the name of the circle. I'll assume it's c in what follows, so you might want to rename it to match, if necessary.
- (3) Create a point A which is somewhere outside of the circle. (If you used points to create the circle in Step 1, you might already have a point A . If so you'll have to rename points as necessary to make this new point be called A .) For some of what follows, it could be handy to have a point $O = (0, 0)$; you could create that now as well.
- (4) Create the ray \overrightarrow{OA} using the button for the ray tool (in which case you might need a point at the origin) or by typing `Ray[(0,0),A]`.
- (5) GeoGebra's *Reflect* tool can handle circle inversion. (As I described in class, inversion has many similarities to reflections, and can be thought of as "reflecting across a circle.") Depending on your version of GeoGebra, however, you *can't* use the button for the *Reflect* tool to reflect A across the circle c . You must type the following in the input field:

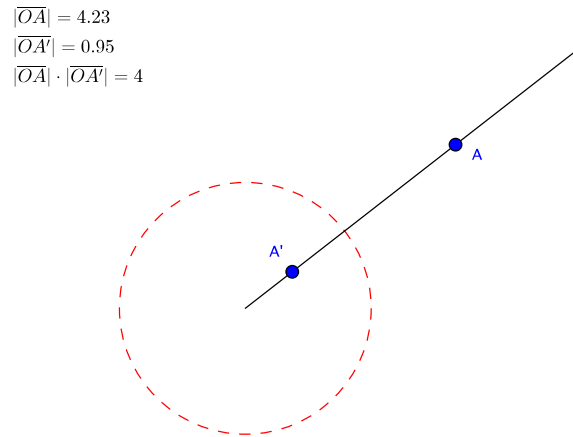
$$\text{Reflect}[A, c]$$

Make sure the resulting point A' is on the ray \overrightarrow{OA} , or something has gone wrong.

- (6) Drag the point A around and observe how A' changes. It should always stay on the ray. What happens if you move A onto the circle? Inside the circle?
- (7) Let's check the distances. Create segments from the origin to A and A' , either with the **Segment** tool or by using commands like `Segment[(0,0),A]` in the Input field. If everything has gone well, the product of the values (i.e. lengths) of the segments should be $4 = \rho^2$, as described in our definition above.
- (8) Now let's add some text labels. Choose the *Text* tool (the square with ABC on it) and click in the upper left of your image. You'll get a box where you can edit the text label. Type the following: `|\overline{OA}| =` and then click the "Objects" dropdown box. Choose the name of the segment from O to A . Hit return to move down

a line, and create a similar label for $\overline{OA'}$ using the name of the segment from O to A' .

- (9) If needed, reposition the text label so everything is visible and nicely arranged. Drag your point A around and make sure the distances update – and that their product is 4, as expected. Here’s a screenshot of my own work for this lab; I’ve also added a label showing the product of the distances and done a bit of styling with the points and circle.



To receive credit for this assignment, save your file as `lastname-5335-lab5.ggb` and attach it to an email to me with subject line **Math 5335 Lab 5** by the beginning of class on Wednesday, 11/18/15. For full credit, I should be able to move your point A and see that A' and the labels update. If your diagram has extra “cruft” in it, such as other points, labels for segments, etc. but is otherwise ok, you’ll receive 4 points. So spend a minute to make things look nice!