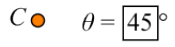
Swirl a Picture (long form) Name:

In the previous activity you created a swirling effect: You rotated an independent point by an angle that depended on the point's distance from a center point, you constructed the range corresponding to a restricted domain, and you animated a parameter to change the function in an interesting way. In this activity you will use the two variables to define a custom transformation, which you'll then apply to several pictures.

REVIEW

Use this section only if you don't have your saved sketch from the previous activity (A Swirling Transformation). Otherwise open your saved sketch and go to step 6.

1. In a new sketch, construct a center point *C* and an angle parameter $\theta = 45°$. Type {theta} for the name of the parameter, and Sketchpad will change the name to θ.
2. Construct independent variable *x* and choose **Transform | Rotate.** With the Rotate dialog box open, click *C* in the sketch to mark it as the center, and click θ to mark it as the angle of rotation. Then click Rotate.

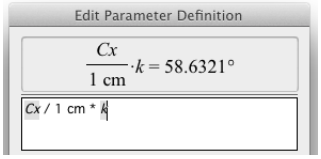


3. Label the rotated point *Swirl[C,{theta}](x)*.

4. Measure the distance *Cx* from the center to the independent variable.

   Select the two points and choose **Measure | Distance.**

5. Select parameter θ and choose **Edit | Edit Parameter.** Use the Calculator to calculate an angle that depends on the distance measurement. To start, delete the current value (15°), click the distance measurement *Cx*, and divide the distance measurement by 1 cm. Then use the Calculator's Value menu to choose **New Parameter,** naming it *k* and giving it a value of 15°. Finally click OK.



A CUSTOM TRANSFORMATION

Now you'll define a custom transformation based on your function.

6. Select *x* and $Swirl_{C,\theta}(x)$, and choose **Transform | Define Custom Transform.** Change the transformation's name to "Swirl[C,θ]."

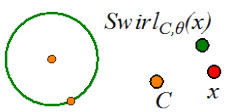
   Define Custom Transform defines a function from two points. (One must depend on the other.)

7. Construct a ray starting from point *C*, and then choose **Transform | Swirl[C,θ].** The transformed ray appears.

Q1 What does the transformed ray look like?

Q2 How is using the **Transform | Swirl[C,θ]** command similar to using the **Locus** command, and how is it different?

8. Use the **Compass** tool to construct a circle away from point *C*. With the circle selected, choose **Transform | Swirl[C,θ].**



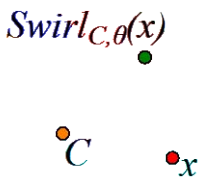
Q3 Draw a picture of the transformed circle. To understand its shape, drag *x* around the circle, observing $Swirl_{C,\theta}(x)$ as you do so. (You can merge point *x* to the circle to aid in your investigation.) Use your observations to explain the shape.

Q4 Drag the circle so its center is on top of point *C*. What does the transformed circle look like now? Why does this happen?

9. Delete the ray and the circle to prepare for the next steps. (If you merged *x* to the circle, split it first before you delete the circle.)

A TRANSFORMED PICTURE

10. To prepare a picture, open the sketch **Animated Special Effects.gsp.** Go to the Pictures page, and select and copy the Sectors picture.
11. Switch back to the sketch you've been working on, select point *C*, and paste the picture.
12. Select the picture and choose **Transform | Swirl[C,θ].** The transformed picture appears.



13. Create a Hide/Show button so you can easily view either the original or the transformed picture.
14. Drag point *x* around on the picture, and observe the behavior of $Swirl_{C,\theta}(x)$. Use points *x* and $Swirl_{C,\theta}(x)$, along with the Hide/Show button, to understand how the transformed picture is related to the original picture.

Q5 Describe in your own words how the **Swirl[C,θ]** function has changed the picture.

15. Create an Animation button to animate parameter *k* bidirectionally between –90° and 90°.

Q6 Press the button and describe how the animation affects the transformation.

16. Press the button again to stop the animation.
17. Replace the picture you used with the Highway picture from **Animated Special Effects.gsp.** To do so, copy the new picture and then switch back to your sketch, select the existing picture, and choose **Edit | Paste Replacement Picture.** You may need to resize the picture by dragging one of its corners.
18. Press the animation button again to animate the swirling of the picture.

EXPLORE MORE

Q7 Swirl some pictures from the Picture Gallery and describe the results.

Choose **Help | Picture Gallery** and drag a new gallery picture onto the picture in your sketch.

Q8 Invent your own special-effect function and apply it to a picture. Create and adjust an Animation button to produce the special effect you want.

Q9 Open **Animated Special Effects.gsp** and try the challenges you find there.

Swirl a Picture (short form) Name:

In the previous activity you created and animated a new function family to produce a swirling effect. In this activity you will use the two variables of the swirling function to define a custom transformation, which you'll then apply to several pictures.

A CUSTOM TRANSFORMATION

1. Open your sketch from the last activity. On the page with your original Swirl construction, select x and $Swirl_{C,\theta}(x)$, and choose **Transform | Define Custom Transform.** Name the custom transformation "Swirl[C,θ]."

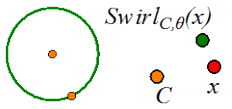
   Define Custom Transform defines a function from two points.(One must depend on the other.)

2. Construct a ray starting from point *C*. Then choose **Transform | Swirl[C,θ].**

Q1 What does the transformed ray look like?

Q2 How is using the **Transform | Swirl[C,θ]** command similar to using the **Locus** command, and how is it different?

3. Construct a circle away from point *C*. With the circle selected, choose **Transform | Swirl[C,θ].**



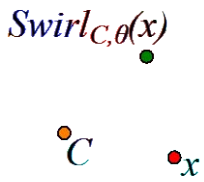
Q3 Draw a picture of the transformed circle. To understand its shape, drag x around the circle, observing $Swirl_{C,\theta}(x)$ as you do so. (You can merge point x to the circle to aid in your investigation.) Use your observations to explain the shape.

Q4 Drag the circle so its center is on top of point *C*. What does the transformed circle look like now? Why does this happen?

4. Delete the ray and the circle to prepare for the next steps. (If you merged x to the circle, split it first before you delete the circle.)

A TRANSFORMED PICTURE

5. To prepare a picture, open the sketch **Animated Special Effects.gsp** and copy the Sectors picture. Switch back to the sketch you've been working on, select point *C*, and paste the picture. Then choose **Transform | Swirl[C,θ].**



6. Create a Hide/Show button so you can easily view either the original or the transformed picture. Use points x and $Swirl_{C,\theta}(x)$, along with the Hide/Show button, to understand how the transformed picture is related to the original picture.

Q5 Describe in your own words how the **Swirl[C,θ]** function has changed the picture.

7. Create a button to animate parameter k bidirectionally between $-90°$ and $90°$.

Q6 Press the button and describe how the animation affects the transformation.

8. Replace the picture you used with the Highway picture from **Animated Special Effects.gsp.** (Copy the Highway picture, switch back to your sketch, select the existing picture, and choose **Edit | Paste Replacement Picture.**) You may need to resize the picture.

11. Press the animation button again to animate the picture.

EXPLORE MORE

Q7 Swirl some pictures from the Picture Gallery and describe the results.

Choose **Help | Picture Gallery** and drag a new gallery picture onto the picture in your sketch.

Q8 Invent your own special-effect function and apply it to a picture. Create and adjust an Animation button to produce the special effect you want.

Q9 Open **Animated Special Effects.gsp** and try the challenges you find there.

Swirl a Picture Answers Name:

Q1 What does the transformed ray look like?

Q2 How is using the **Transform | Swirl[C,θ]** command similar to using the **Locus** command, and how is it different?

Q3 Draw a picture of the transformed circle. To understand its shape, drag *x* around the circle, observing $Swirl_{C,\theta}(x)$ as you do so. (You can merge point *x* to the circle to aid in your investigation.) Use your observations to explain the shape.

Q4 Drag the circle so its center is on top of point *C*. What does the transformed circle look like now? Why does this happen?

Q5 Describe in your own words how the **Swirl[C,θ]** function has changed the picture.

Q6 Press the button and describe how the animation affects the transformation.

Q7 Swirl some pictures from the Picture Gallery and describe the results.

Q8 Invent your own special-effect function and apply it to a picture. Create and adjust an Animation button to produce the special effect you want.

Q9 Open **Animated Special Effects.gsp** and try the challenges you find there. (Ask your teacher how to present your work on the challenges.)

Swirl a Picture Exit Ticket Name:

1. Describe something that surprised you or puzzled you as you did this activity.

2. How is this family of swirling functions similar to other function families, and how is it different?

