Teacher Notes

Activity 11

Exploring Polar Equations

Objective

- The student will explore the polar equation defined by $r(\theta) = a + b\cos(n\theta)$ and $r(\theta) = a + b\sin(n\theta)$ and examine the effects that the parameters *a*, *b*, and *n* have on the graphs.

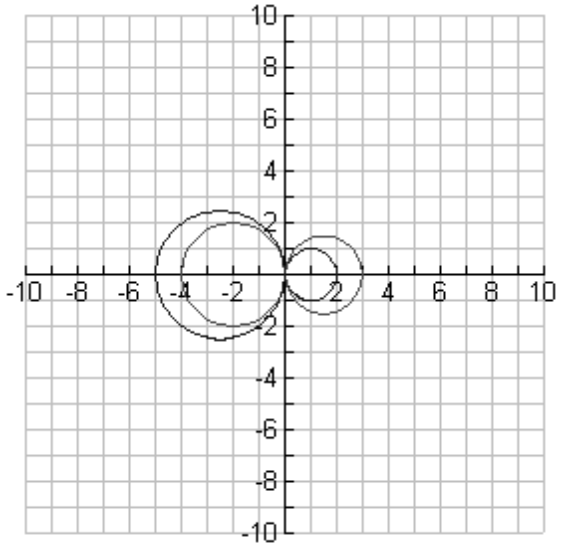
Applicable TI InterActive! Functions

- Graph 
- Define *variable* := *value*

Problem

By changing the values of *a*, *b*, and *n* in the polar equations $r(\theta) = a + b\cos(n\theta)$ and $r(\theta) = a + b\sin(n\theta)$ different polar curves, such as a circle, rose, limaçon, and cardiod can be created. In this activity, students will create the different curves and discover how the parameters *a*, *b* and *n* create the different curves.

1. through 7.



8. $a = 0$ $n = 1$

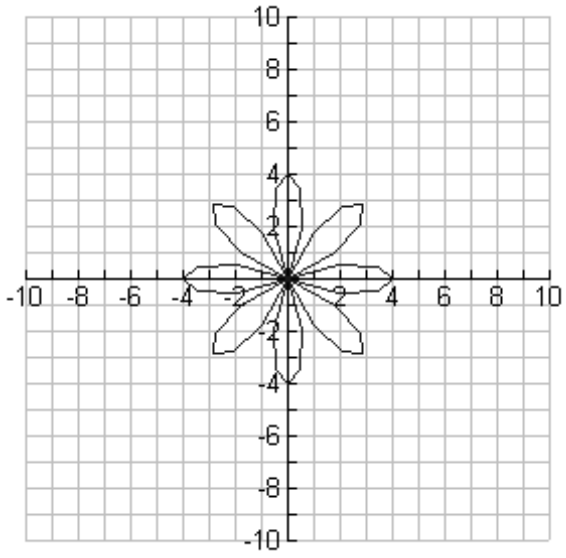
9. It increases the radius of the circle.

10. If the value of *b* is negative, the circle is reflected about the *y*-axis.

Rose Polar Curve Exploration

1. through 5.

   Note: *This is the graph of* $r(\theta) = 4\cos(4\theta)$



Rose Polar Curve Analysis

1. $a = 0$ $b = 4$

2. A. 1 B. 4

   C. 3 D. 8

3. If n is odd, it equals the number of leaves. If it is even, then the number of leaves is twice n.

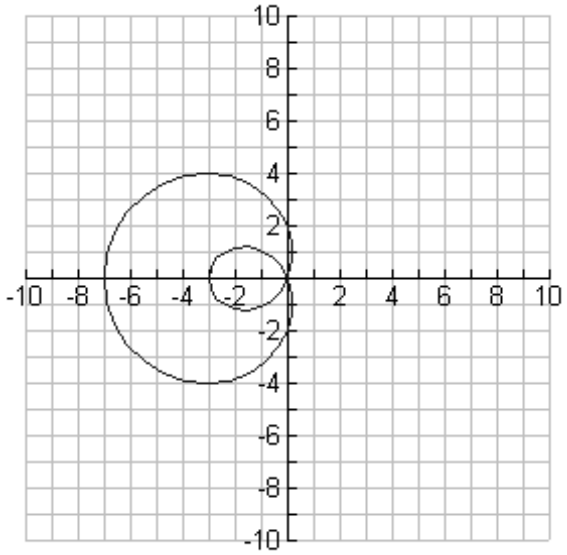
4. The value of b increases the length of each leave.

5. If the value of b is negative, the rose is reflected about the y-axis.

Limaçon Curve Exploration

1. through 5.

   Note: *This is the graph of* $r(\theta) = 2 - 5\cos(\theta)$

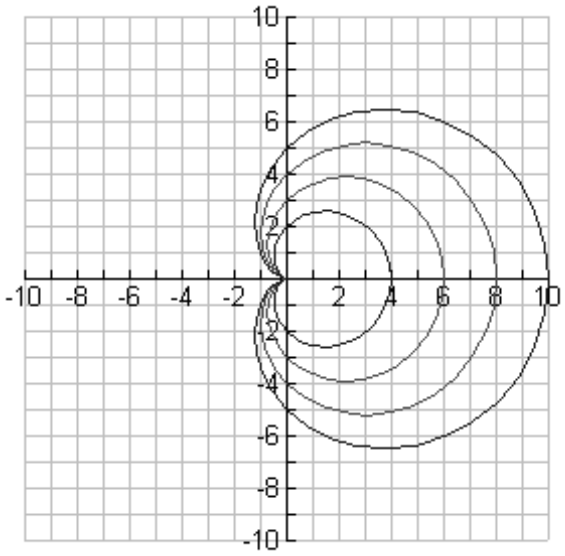


Limaçon Curve Analysis

1. $n = 1$
2. The absolute value of b is always greater than the absolute value of a.
3. The greater their sum, the bigger the outer loop.
4. If the value of b is negative, the limaçon is reflected about the y-axis.

Cardiod Curve Exploration

1. through 5.



Cardiod Curve Analysis

1. $n = 1$
2. The absolute values of a and b are equal.
3. The greater their sum, the bigger the loop.
4. If the value of b is negative, the cardiod is reflected about the y-axis.

Additional Exercises Notes and Solutions

For the additional exercises, students should change the Mode settings to Polar. The values a, b and n should be defined in a math box prior to defining $r(\theta) := a + b \sin(n\theta)$. By clicking on each math box, the parameters can be changed and the effects observed.

1. The graph is a circle with a radius of 2 and lies along the positive y-axis.
2. The graph is a circle with a radius of 4 and lies along the positive y-axis.
3. The graph is a circle with a radius of 6 and lies along the negative y-axis.
4. The graph is a rose with 4 leaves of length 2.
5. The graph is a rose with 3 leaves of length 2.
6. The graph is a rose with 8 leaves of length 3 that is reflected about the y-axis.
7. The graph is a limaçon that lies along the positive y-axis.
8. The graph is a cardiod that lies along the positive y-axis.
9. The graph is a limaçon that lies along the negative y-axis.
10. The graph is a limaçon that lies along the negative y-axis.
11. The polar curve $r(\theta) = a + b \cos(n\theta)$ lies along the x-axis and the curve $r(\theta) = a + b \sin(n\theta)$ lies along the y-axis.
12. A circle is created when $a = 0$ and $n = 1$. A rose is created when $a = 0$ and the value of n is greater than 1. A limaçon is created when the absolute value of b is greater than the absolute value of a. A cardiod is created when the absolute value of b is equal to the absolute value of a.