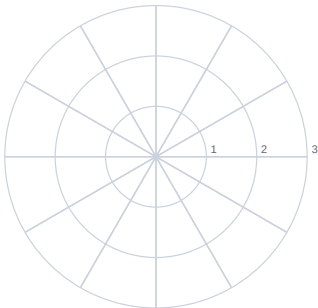


Polar Function Graphs

Use the stated full-trace interval, test the requested symmetry, and plot the key-angle table before drawing the curve.

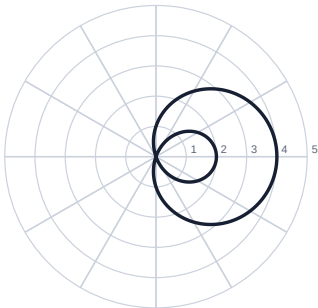
1. Graph $r^2 = 4 \cos(2\theta)$ on $0 \leq \theta \leq 2\pi$. Test polar-axis symmetry with $\theta \rightarrow -\theta$, vertical-axis symmetry with $\theta \rightarrow \pi - \theta$, and pole symmetry with $\theta \rightarrow \theta + \pi$. Complete the key-value table; for a squared-radius equation, tabulate the nonnegative root.

θ	0	$\pi/4$	$\pi/2$	π	$3\pi/2$	2π
r						



numbered radial scale

2. Identify the completed polar graph's family and write a matching equation. Use the numbered radial scale. State its symmetries.



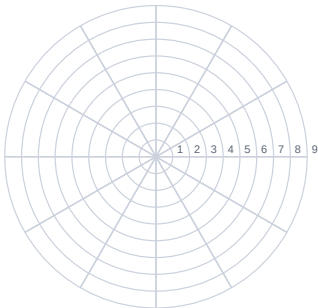
completed graph with numbered radial scale

Polar Function Graphs

Use the stated full-trace interval, test the requested symmetry, and plot the key-angle table before drawing the curve.

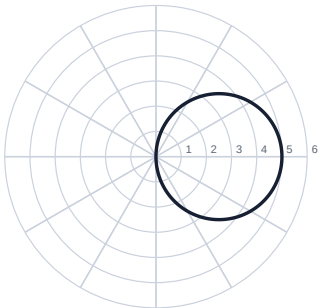
3. Graph $r = 4(1 + \cos(\theta))$ on $0 \leq \theta \leq 2\pi$. Test polar-axis symmetry with $\theta \rightarrow -\theta$, vertical-axis symmetry with $\theta \rightarrow \pi - \theta$, and pole symmetry with $\theta \rightarrow \theta + \pi$. Complete the key-value table; for a squared-radius equation, tabulate the nonnegative root.

theta	0	pi/4	pi/2	pi	3pi/2	2pi
r						



numbered radial scale

4. Identify the completed polar graph's family and write a matching equation. Use the numbered radial scale. State its symmetries.



completed graph with numbered radial scale

Polar Function Graphs
Worked Answer Key

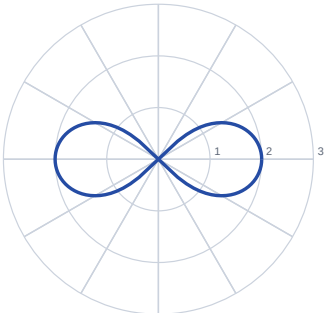
Use the stated full-trace interval, test the requested symmetry, and plot the key-angle table before drawing the curve.

1. Graph $r^2 = 4 \cos(2\theta)$ on $0 \leq \theta \leq 2\pi$. Test polar-axis symmetry with $\theta \rightarrow -\theta$, vertical-axis symmetry with $\theta \rightarrow \pi - \theta$, and pole symmetry with $\theta \rightarrow \theta + \pi$. Complete the key-value table; for a squared-radius equation, tabulate the nonnegative root.

θ	0	$\pi/4$	$\pi/2$	π	$3\pi/2$	2π
r	2	0	undefined	2	undefined	2

Answer: lemniscate traced once on $0 \leq \theta \leq 2\pi$; symmetric about the polar axis, the line $\theta = \pi/2$, and the pole.

1. Apply each stated substitution to the equation and report only the symmetries that preserve it.
2. When $\cos(2\theta) < 0$, r is not real; leave those table cells undefined and do not connect across the gaps.

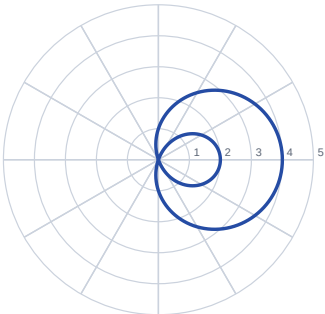


completed graph with numbered radial scale

2. Identify the completed polar graph's family and write a matching equation. Use the numbered radial scale. State its symmetries.

Answer: limaçon; $r = 1 + 3 \cos(\theta)$; symmetric about the polar axis.

1. Use the numbered radial scale to read the maximum radius, then count loops or petals.
2. Check the equation at a maximum and at a pole crossing.



completed graph with numbered radial scale

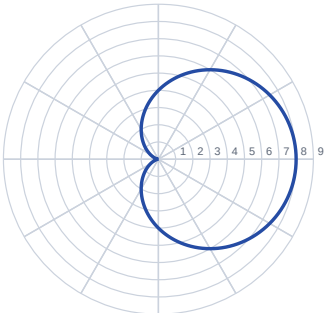
Polar Function Graphs
Worked Answer Key

Use the stated full-trace interval, test the requested symmetry, and plot the key-angle table before drawing the curve.

3. Graph $r = 4(1 + \cos(\theta))$ on $0 \leq \theta \leq 2\pi$. Test polar-axis symmetry with $\theta \rightarrow -\theta$, vertical-axis symmetry with $\theta \rightarrow \pi - \theta$, and pole symmetry with $\theta \rightarrow \theta + \pi$. Complete the key-value table; for a squared-radius equation, tabulate the nonnegative root.

θ	0	$\pi/4$	$\pi/2$	π	$3\pi/2$	2π
r	8	$4(1+\sqrt{2}/2)$	4	0	4	8

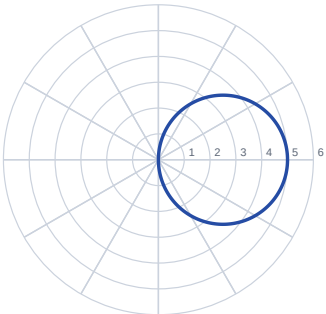
- Answer: cardioid traced once on $0 \leq \theta \leq 2\pi$; symmetric about the polar axis.
1. Apply each stated substitution to the equation and report only the symmetries that preserve it.
 2. Plot signed radii and connect in increasing- θ order.



completed graph with numbered radial scale

4. Identify the completed polar graph's family and write a matching equation. Use the numbered radial scale. State its symmetries.

- Answer: circle; $r = 5 \cos(\theta)$; symmetric about the polar axis.
1. Use the numbered radial scale to read the maximum radius, then count loops or petals.
 2. Check the equation at a maximum and at a pole crossing.



completed graph with numbered radial scale