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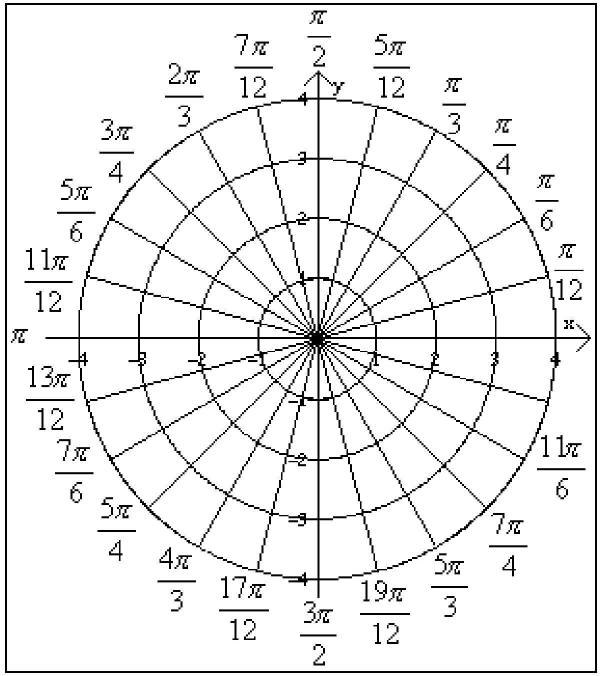
Polar Coordinates

Differences: Polar vs. Rectangular

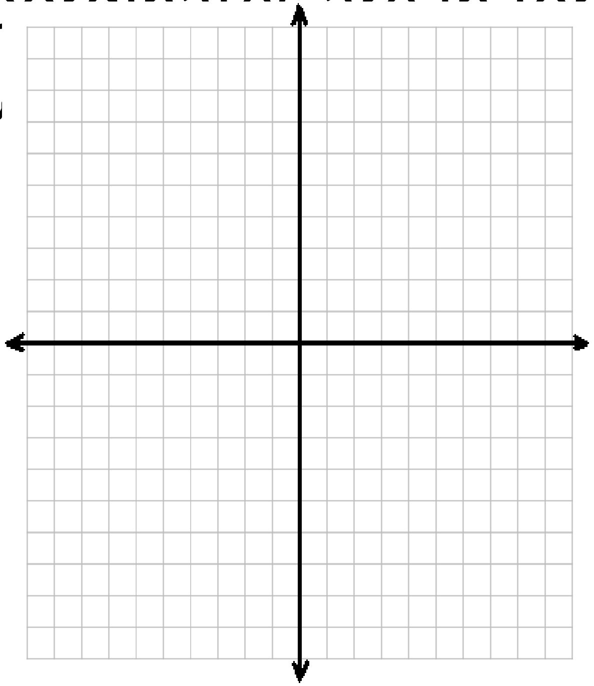
POLAR

- (0,0) is called the pole
- Coordinates are in form (r, θ)



RECTANGULAR

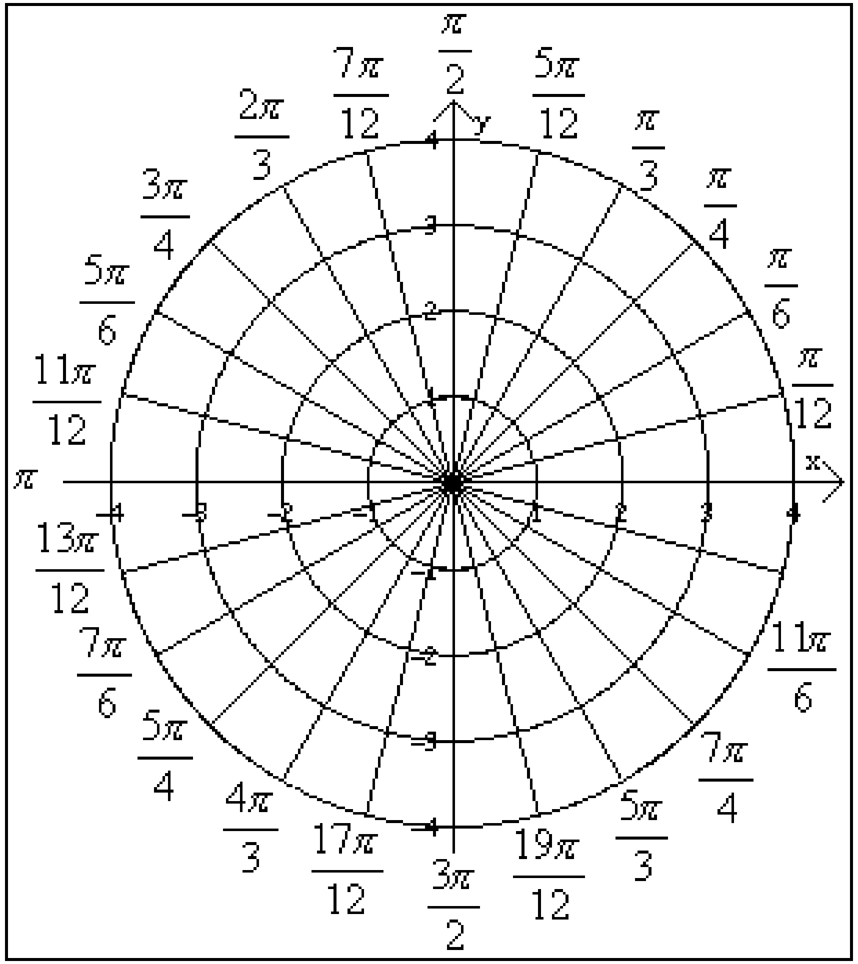
- (0,0) is called the origin
- Coordinates are in form (x,



How to Graph Polar Coordinates

- **Given:**

(3, л/3)



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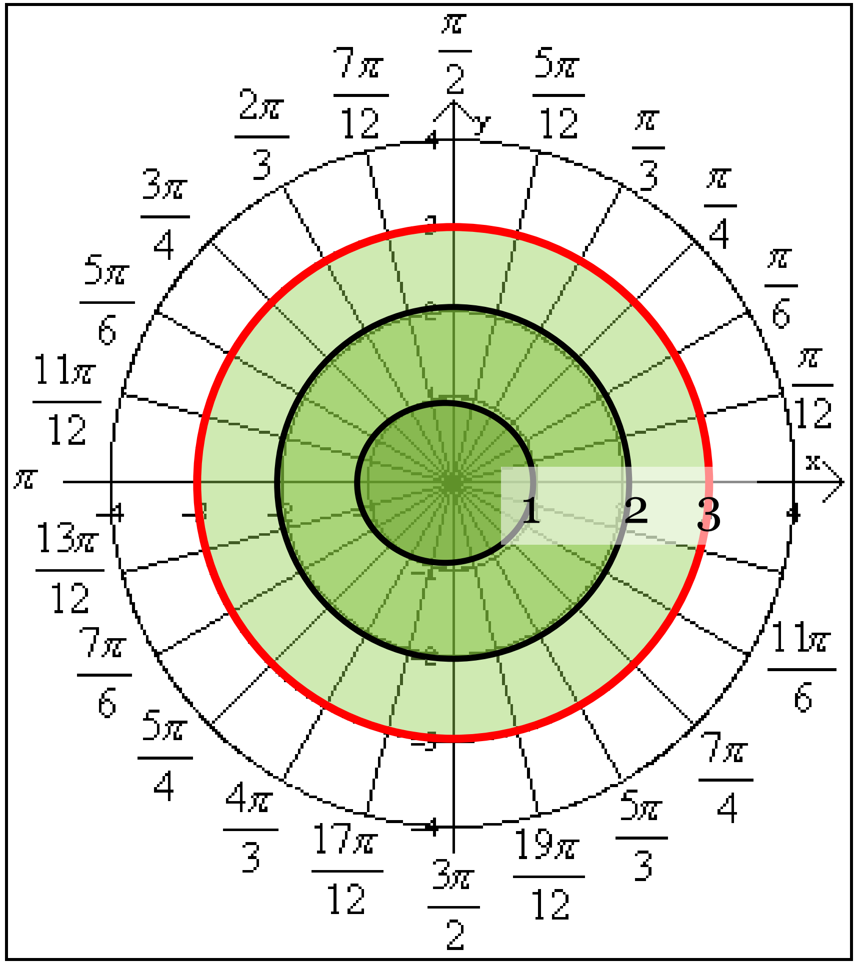
Answer- STEP ONE

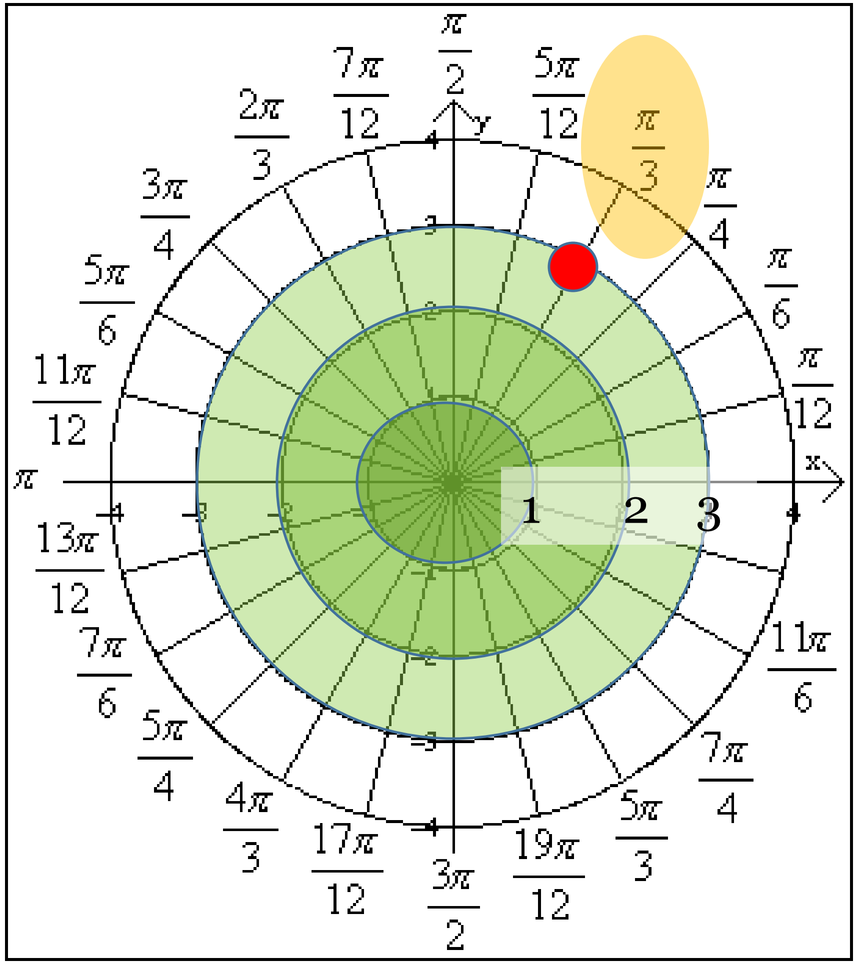
- Look at *r* and move that number of circles out
- Move 3 units out (highlighted in red)



Answer- STEP TWO

- Look at θ- this tells you the direction/angle of the line

- Place a point where the *r* is on that angle.
- In this case, the angle is л/3



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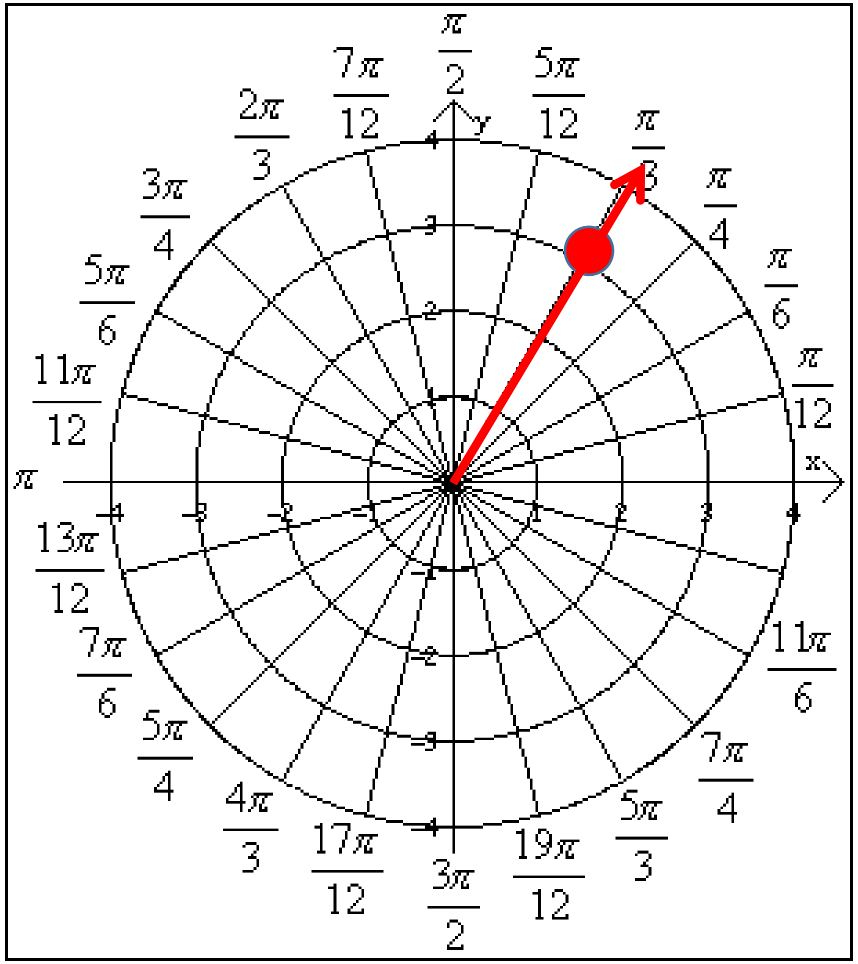
Answer: STEP THREE

- Draw a line from the origin through the point



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Converting Coordinates

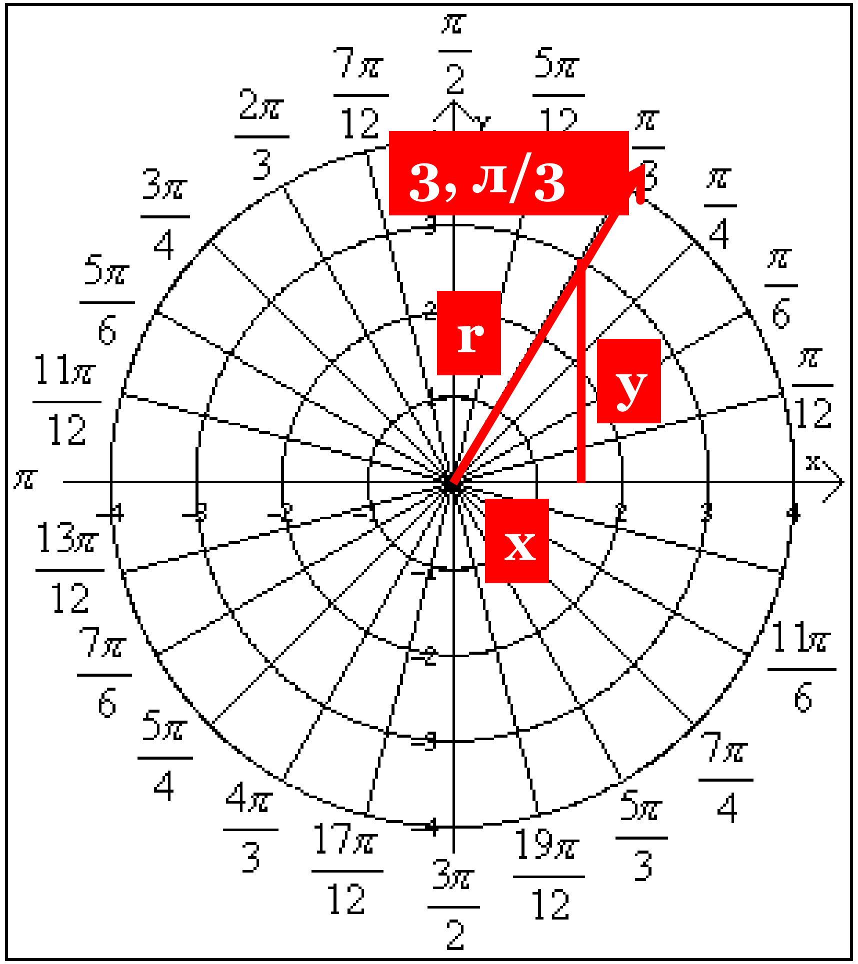
- Remember: The hypotenuse has a length of *r*. The sides are *x* and *y*.
- By using these properties, we get that:

$x = r\cos\vartheta$

$y = r\sin\vartheta$

$\tan\vartheta = y/x$

$r^2 = x^2 + y^2$



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CONVERT: Polar to Rectangle: (3, л/3)

- x=3cos (л/3) → x=3cos(60) → 1.5
- y=3sin(л/3) → x=3sin(60) → 2.6
- New coordinates are (1.5, 2.6)

***$x = r\cos\theta$

***$y=r\sin\theta$

$\tan\theta=y/x$

$r^2=x^2+y^2$

CONVERT: Rectangular to Polar: (1, 1)

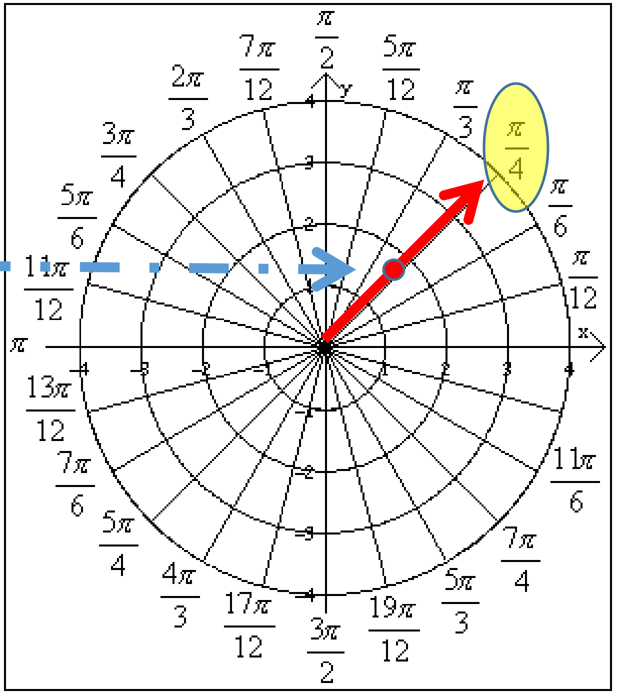
- Find Angle: $\tan\theta = y/x$
  $\tan\theta = 1$

  $\tan^{-1}(1) = \pi/4$

(You could also find *r* by recognizing this is a 45-45-90 right triangle)

- Find *r* by using the equation $r^2 = x^2 + y^2$
- $r^2 = 1^2 + 1^2$
- $r = \sqrt{2}$
- New Coordinates are

$(\sqrt{2}, \pi/4)$



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Convert Equation to Polar: $x^2+y^2+4x=0$

STEP ONE: Substitute into equation

***$x = r\cos\theta$

***$r^2=x^2+y^2$

$r^2+4r\cos\theta=0$ → $r + 4\cos\theta=0$ (factor out r)

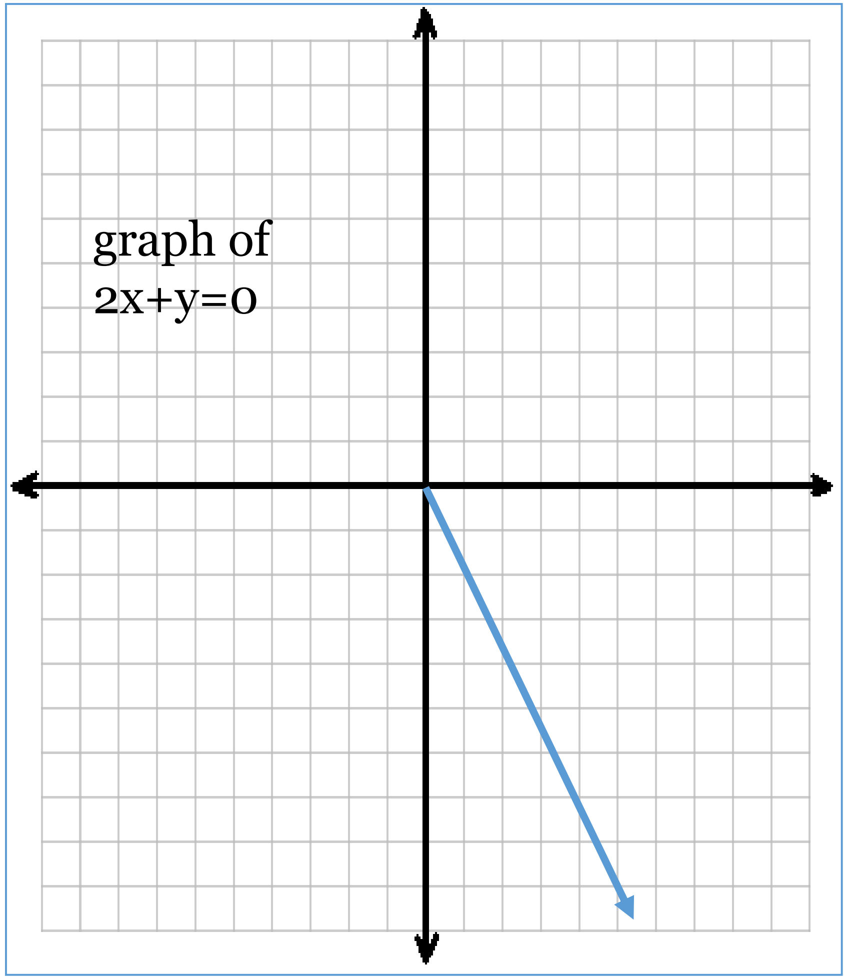
Final Equation: $r= -4\cos\theta$

***$x = r\cos\theta$
$y=r\sin\theta$
$\tan\theta=y/x$
***$r^2=x^2+y^2$

Convert Equation to Polar: 2x+y=0

STEP TWO: Factor out *r*

$r(2\cos\theta + \sin\theta) = 0$



***$\underline{x = r\cos\theta}$

***$\underline{y=r\sin\theta}$

$\underline{\tan\theta=y/x}$

$\underline{r^2=x^2+y^2}$

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SYMMETRY: THINGS TO REMEMBER

- When graphing, use these methods to test the symmetry of the equation

Symmetry with line л/2	Replace (r, θ) with (-r, -θ)
Symmetry with polar axis	Replace (r, θ) with (r, -θ)
Symmetry with pole	Replace (r, θ) with (-r, θ)

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Graphing Equations with Symmetry

- GRAPH: r=2+3cosθ
- ANSWER: STEP ONE: Make a Table and Choose Angles. Solve the equation for *r*.

θ	r
0	5
л/6	$\frac{3\sqrt{3}}{2}+2$
л/4	$\frac{3\sqrt{2}}{2}+2$
л/3	$\frac{5}{2}$
л/2	2
2л./3	$\frac{5}{2}$
5л/6	$\frac{3\sqrt{3}}{2}+2$
л	undefined

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Graphing Equations with Symmetry

- GRAPH: r=2+3cosθ
- ANSWER: STEP TWO: Determine Symmetry

Test for symmetry along polar axis:
Replace (r, θ) with (r, -θ)

test with -л/3: r = 2+3cos(-л/3)

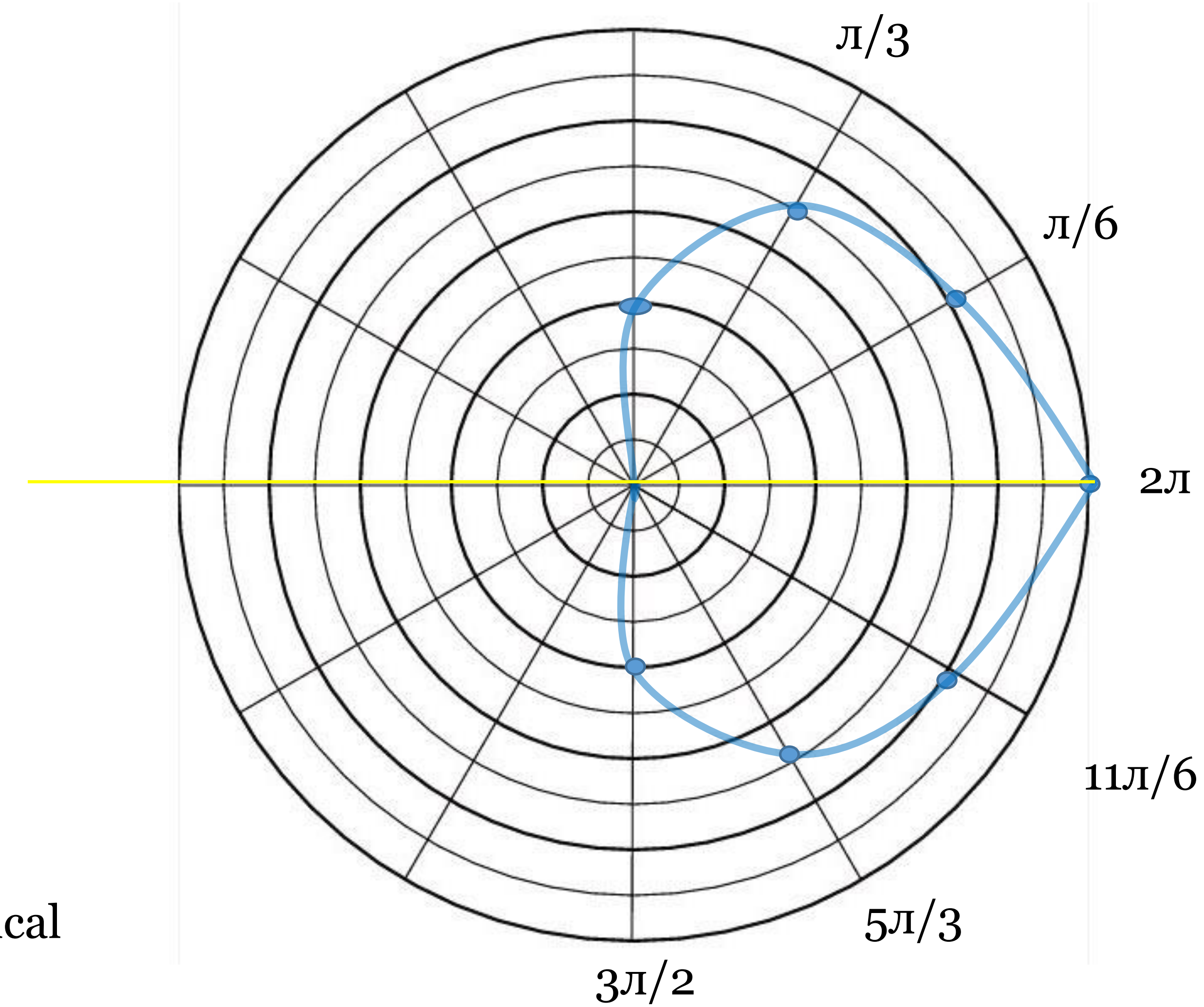
$$r = \frac{5}{2}$$

Since the answer is the same, we know that this graph is symmetric along the polar axis

θ	r
0	5
л/6	$\frac{3\sqrt{3}}{2} + 2$
л/4	$\frac{3\sqrt{2}}{2} + 2$
л/3	$\frac{5}{2}$
л/2	2
2л./3	$\frac{5}{2}$
5л/6	$\frac{3\sqrt{3}}{2} + 2$
л	undefined

Graph Answer: $r=2+3\cos\theta$

θ	r
0	5
л/6	$\frac{3\sqrt{3}}{2}+2$
л/4	$\frac{3\sqrt{2}}{2}+2$
л/3	$\frac{7}{2}$
л/2	2
3л/2	2
5л/3	$\frac{7}{2}$
11л/6	$\frac{3\sqrt{3}}{2}+2$
л	undefined



We know it is symmetrical through the polar axis