

# MTH 2227 - HW #2 Graphing Equations in Polar Coordinates - Solutions

SPRING 2018

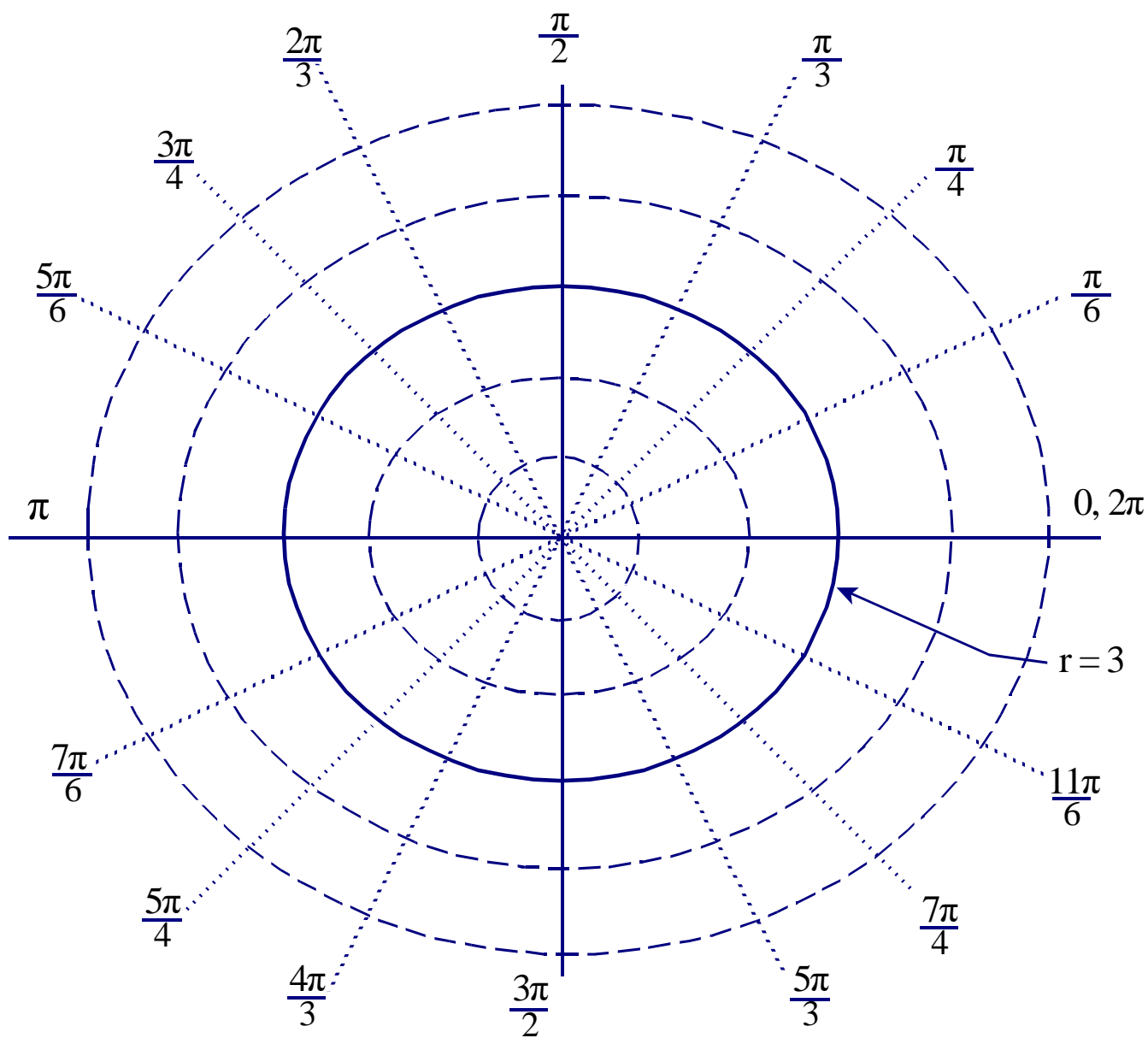
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Name \_\_\_\_\_

The equations below relate  $r$  as a function of  $\theta$ . Graph the equations.

1.  $r = 3$

**Recall:** This is a special form.  $r = 3$  for all values of  $\theta$ . So this is a circle of radius 3, centered at the origin.

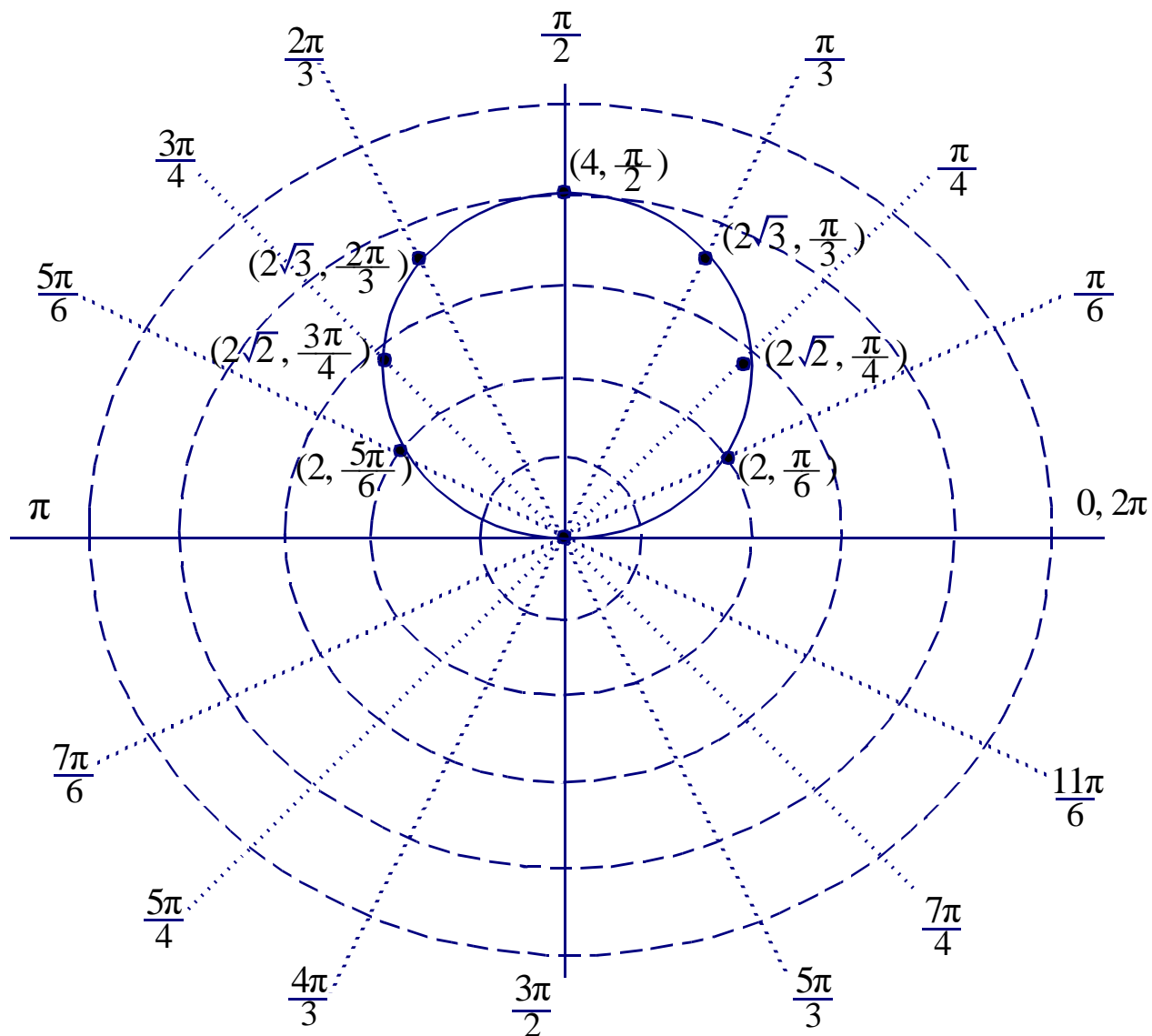


2.  $r = 4 \sin(\theta)$

We will plot values of  $r$  for the “standard values of  $\theta$ ,” using the approximations:  $\sqrt{2} \approx 1.4$  and  $\sqrt{3} \approx 1.73$

$\theta =$	$r = 4 \sin(\theta)$	$\theta =$	$r = 4 \sin(\theta)$
0	0		
$\frac{\pi}{6}$	2	$\frac{7\pi}{6}$	-2
$\frac{\pi}{4}$	$2\sqrt{2}$	$\frac{5\pi}{6}$	$-2\sqrt{2}$
$\frac{\pi}{3}$	$2\sqrt{3}$	$\frac{4\pi}{3}$	$-2\sqrt{3}$
$\frac{\pi}{2}$	4	$\frac{3\pi}{2}$	-4
$\frac{2\pi}{3}$	$2\sqrt{3}$	$\frac{5\pi}{3}$	$-2\sqrt{3}$
$\frac{3\pi}{4}$	$2\sqrt{2}$	$\frac{7\pi}{6}$	$-2\sqrt{2}$
$\frac{5\pi}{6}$	2	$\frac{11\pi}{6}$	-2
$\pi$	0	$2\pi$	0

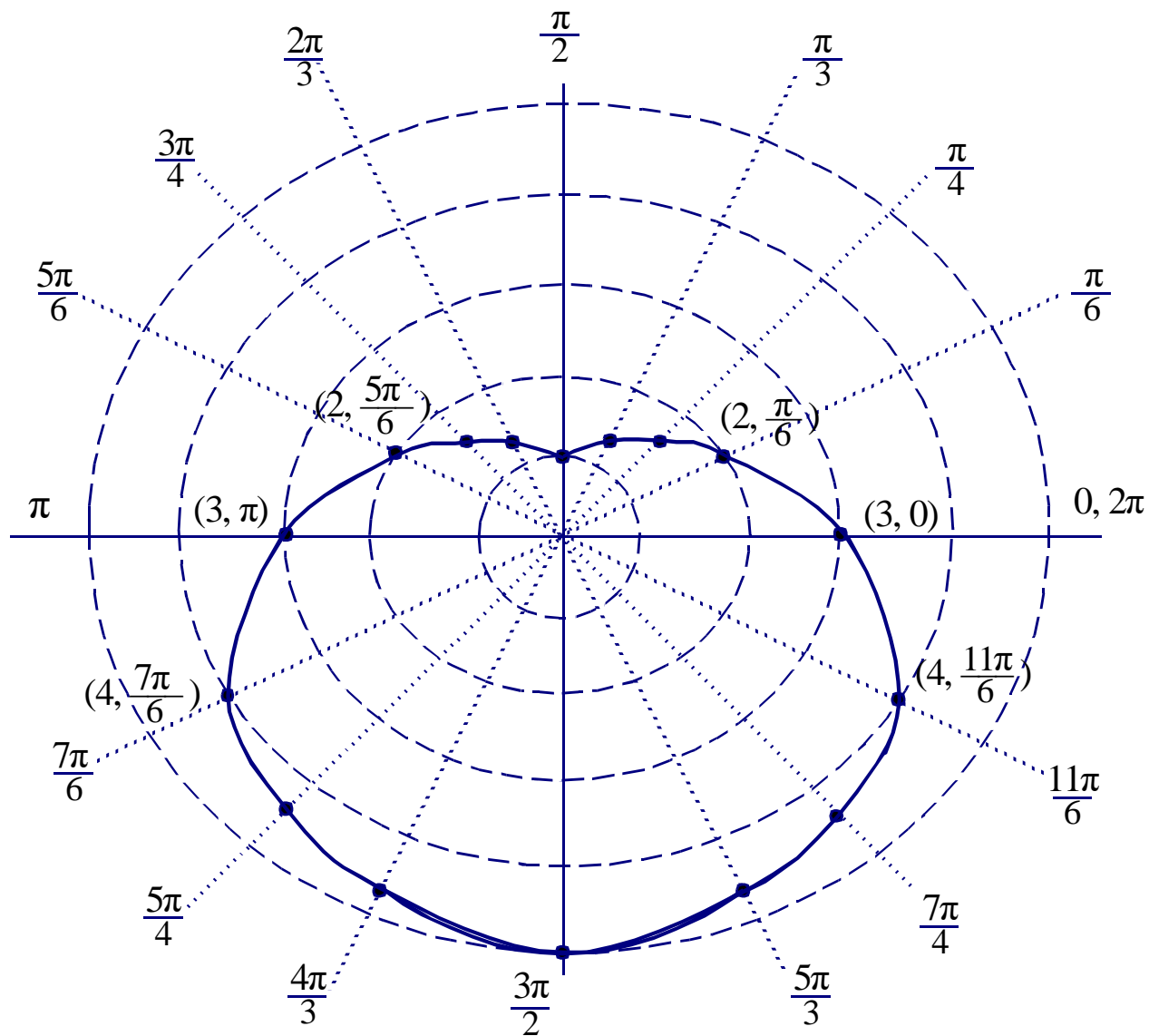
The values in the columns on the right produce points that are duplicates of the points that come from the values in the columns on the left.



3.  $r = 3 - 2 \sin(\theta)$

We will plot values of  $r$  for the “standard values of  $\theta$ ,” using the approximations:  $\sqrt{2} \approx 1.4$  and  $\sqrt{3} \approx 1.7$

		$\theta =$	$r = 3 - 2 \sin(\theta)$
0	3		
$\frac{\pi}{6}$	2	$\frac{7\pi}{6}$	4
$\frac{\pi}{4}$	$3 - \sqrt{2} = 1.586$	$\frac{5\pi}{4}$	$3 + \sqrt{2} = 4.414$
$\frac{\pi}{3}$	$3 - \sqrt{3} = 1.27$	$\frac{4\pi}{3}$	$3 + \sqrt{3} = 4.7$
$\frac{\pi}{2}$	1	$\frac{3\pi}{2}$	5
$\frac{2\pi}{3}$	$3 - \sqrt{3} = 1.27$	$\frac{5\pi}{3}$	$3 + \sqrt{3} = 4.7$
$\frac{3\pi}{4}$	$3 - \sqrt{2} = 1.586$	$\frac{7\pi}{4}$	$3 + \sqrt{2} = 4.414$
$\frac{5\pi}{6}$	2	$\frac{11\pi}{6}$	4
$\pi$	3	$2\pi$	3

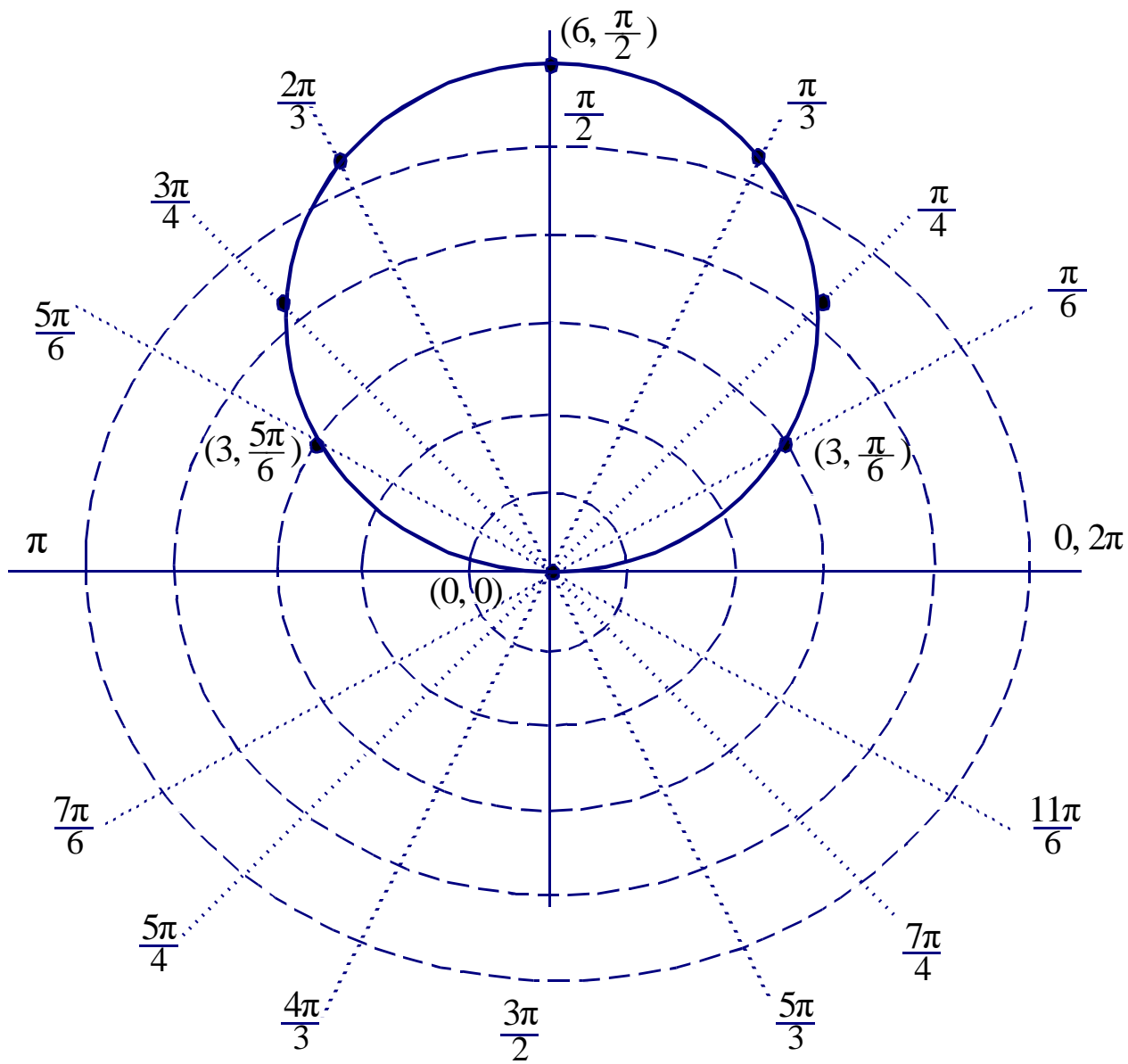


4.  $r = 6 \sin(\theta)$

We will plot values of  $r$  for the “standard values of  $\theta$ ,” using the approximations:  $\sqrt{2} \approx 1.4$  and  $\sqrt{3} \approx 1.7$

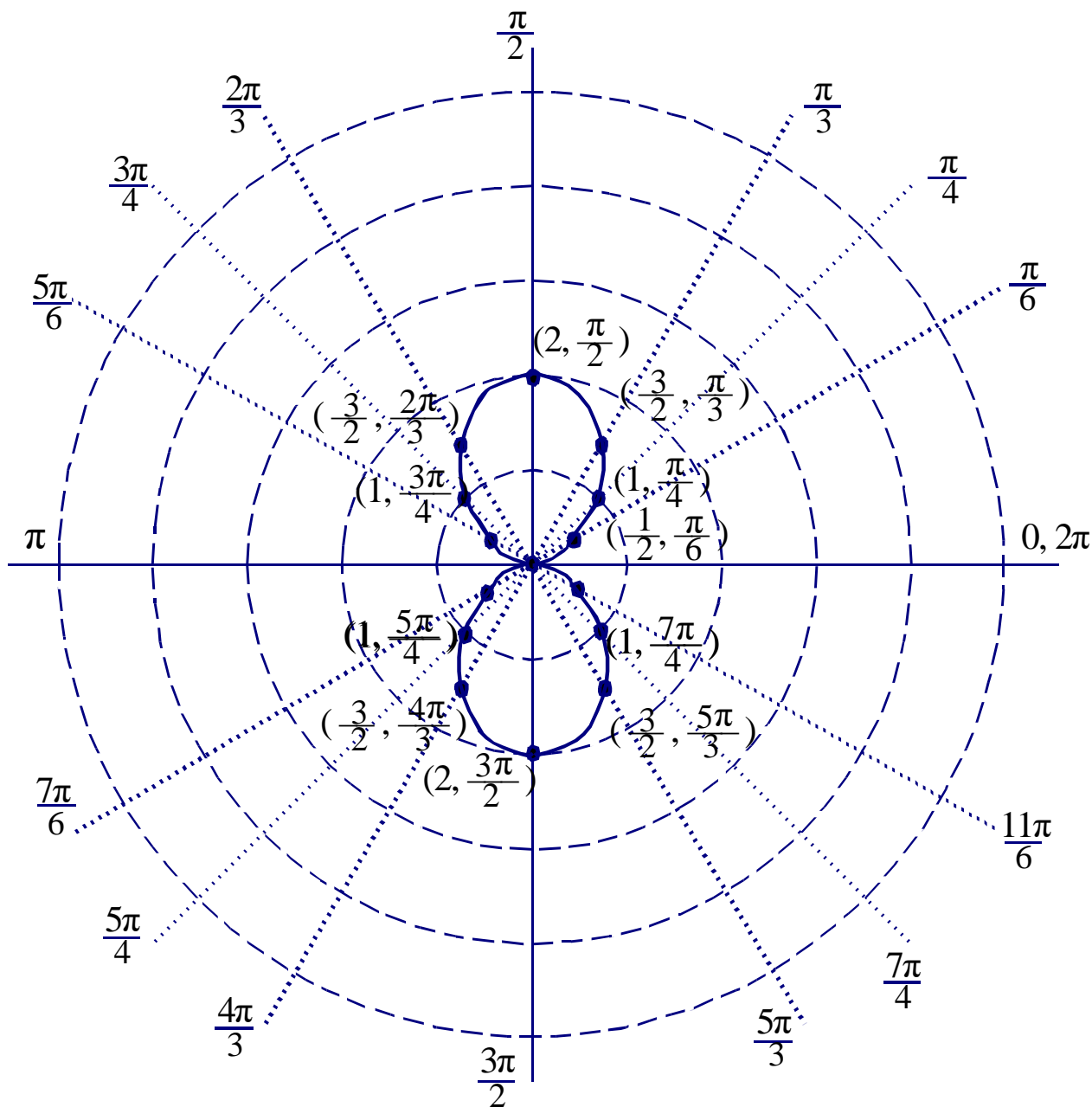
$\theta =$	$r = 6 \sin(\theta)$	$\theta =$	$r = 6 \sin(\theta)$
0	0		
$\frac{\pi}{6}$	3	$\frac{7\pi}{6}$	-3
$\frac{\pi}{4}$	$3\sqrt{2}$	$\frac{5\pi}{6}$	$-3\sqrt{2}$
$\frac{\pi}{3}$	$3\sqrt{3}$	$\frac{4\pi}{3}$	$-3\sqrt{3}$
$\frac{\pi}{2}$	6	$\frac{3\pi}{2}$	-6
$\frac{2\pi}{3}$	$3\sqrt{3}$	$\frac{5\pi}{3}$	$-3\sqrt{3}$
$\frac{3\pi}{4}$	$3\sqrt{2}$	$\frac{7\pi}{6}$	$-3\sqrt{2}$
$\frac{5\pi}{6}$	3	$\frac{11\pi}{6}$	-3
$\pi$	0	$2\pi$	0

The values in the columns on the right produce points that are duplicates of the points that come from the values in the columns on the left.



5.  $r = 1 - \cos(2\theta)$  Plot using the regular Polar Grid. Plot only the points corresponding to the whole number multiples of  $\theta = \frac{\pi}{18}$ , for  $0 \leq \theta \leq \pi$

$\theta =$	$r = 1 - \cos(2\theta)$	$\theta =$	$r = 1 - \cos(2\theta)$
0	$1 - \cos(0) = 0$		
$\frac{\pi}{6}$	$1 - \cos\left(\frac{\pi}{3}\right) = 0.5$	$\frac{7\pi}{6}$	$1 - \cos\left(\frac{7\pi}{3}\right) = 0.5$
$\frac{\pi}{4}$	$1 - \cos\left(\frac{\pi}{2}\right) = 1$	$\frac{5\pi}{4}$	$1 - \cos\left(\frac{5\pi}{2}\right) = 1$
$\frac{\pi}{3}$	$1 - \cos\left(\frac{2\pi}{3}\right) = 1.5$	$\frac{4\pi}{3}$	$1 - \cos\left(\frac{8\pi}{3}\right) = 1.5$
$\frac{\pi}{2}$	$1 - \cos(\pi) = 2$	$\frac{3\pi}{2}$	$1 - \cos(3\pi) = 2$
$\frac{2\pi}{3}$	$1 - \cos\left(\frac{4\pi}{3}\right) = 1.5$	$\frac{5\pi}{3}$	$1 - \cos\left(\frac{10\pi}{3}\right) = 1.5$
$\frac{3\pi}{4}$	$1 - \cos\left(\frac{3\pi}{2}\right) = 1$	$\frac{7\pi}{4}$	$1 - \cos\left(\frac{7\pi}{2}\right) = 1$
$\frac{5\pi}{6}$	$1 - \cos\left(\frac{5\pi}{3}\right) = 0.5$	$\frac{11\pi}{6}$	$1 - \cos\left(\frac{11\pi}{3}\right) = 0.5$
$\pi$	$1 - \cos(2\pi) = 0$	$2\pi$	$1 - \cos(4\pi) = 0$

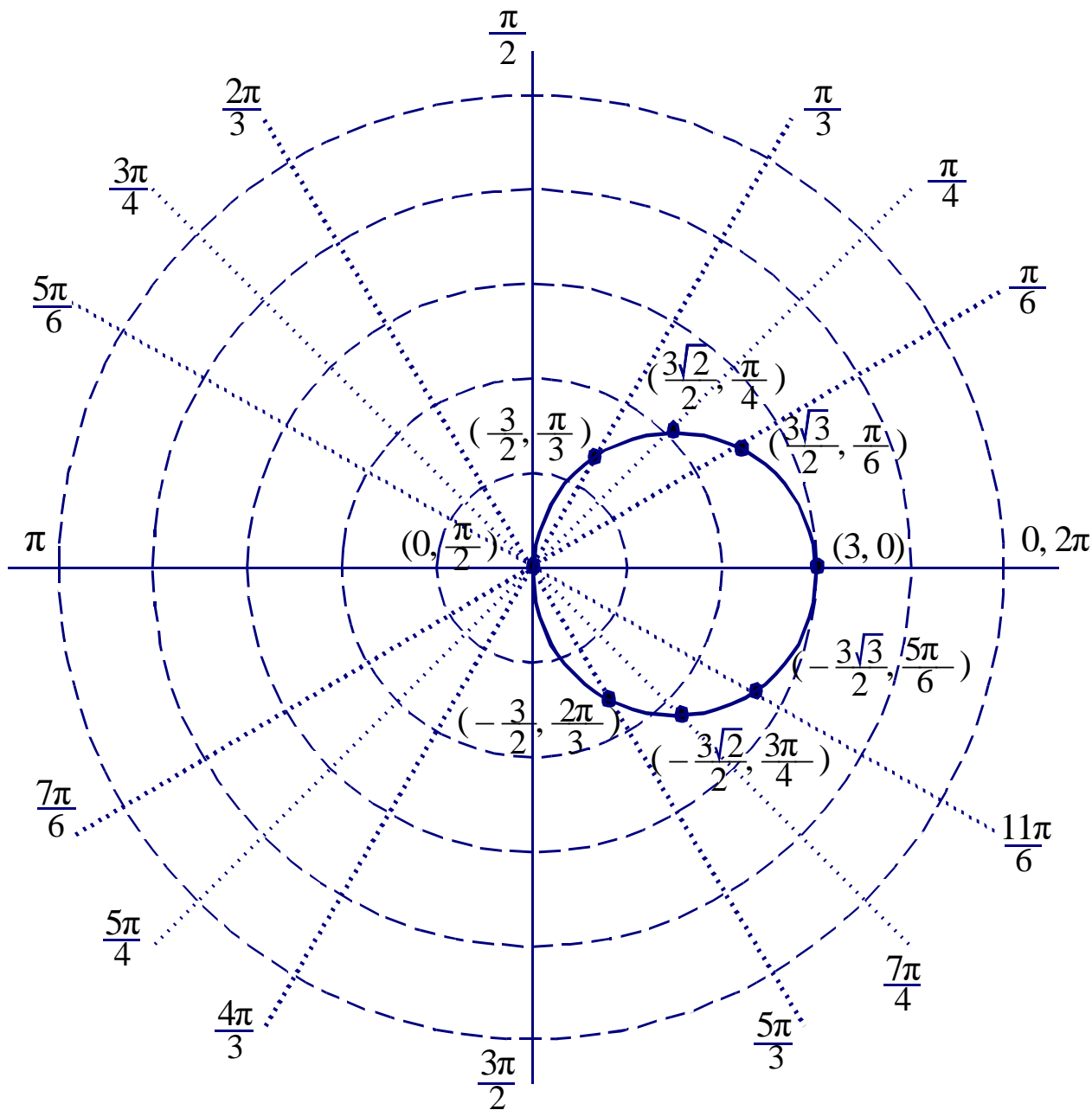


6.  $r = 3 \cos(\theta)$

We plot a table of  $(r, \theta)$  values:

$\theta =$	$r = 3 \cos(\theta)$	$\theta =$	$r = 3 \cos(\theta)$
0	$3 \cos(0) = 3$		
$\frac{\pi}{6}$	$3 \cos(\frac{\pi}{6}) = 2.6$	$\frac{7\pi}{6}$	$3 \cos(\frac{7\pi}{6}) = -2.6$
$\frac{\pi}{4}$	$3 \cos(\frac{\pi}{4}) = 2.12$	$\frac{5\pi}{4}$	$3 \cos(\frac{5\pi}{4}) = -2.12$
$\frac{\pi}{3}$	$3 \cos(\frac{\pi}{3}) = 1.5$	$\frac{4\pi}{3}$	$3 \cos(\frac{4\pi}{3}) = -1.5$
$\frac{\pi}{2}$	$3 \cos(\frac{\pi}{2}) = 0$	$\frac{3\pi}{2}$	$3 \cos(\frac{3\pi}{2}) = 0$
$\frac{2\pi}{3}$	$3 \cos(\frac{2\pi}{3}) = -1.5$	$\frac{5\pi}{3}$	$3 \cos(\frac{5\pi}{3}) = 1.5$
$\frac{3\pi}{4}$	$3 \cos(\frac{3\pi}{4}) = -2.12$	$\frac{7\pi}{4}$	$3 \cos(\frac{7\pi}{4}) = 2.12$
$\frac{5\pi}{6}$	$3 \cos(\frac{5\pi}{6}) = -2.6$	$\frac{11\pi}{6}$	$3 \cos(\frac{11\pi}{6}) = 2.6$
$\pi$	$3 \cos(\pi) = -3$	$2\pi$	$3 \cos(2\pi) = 3$

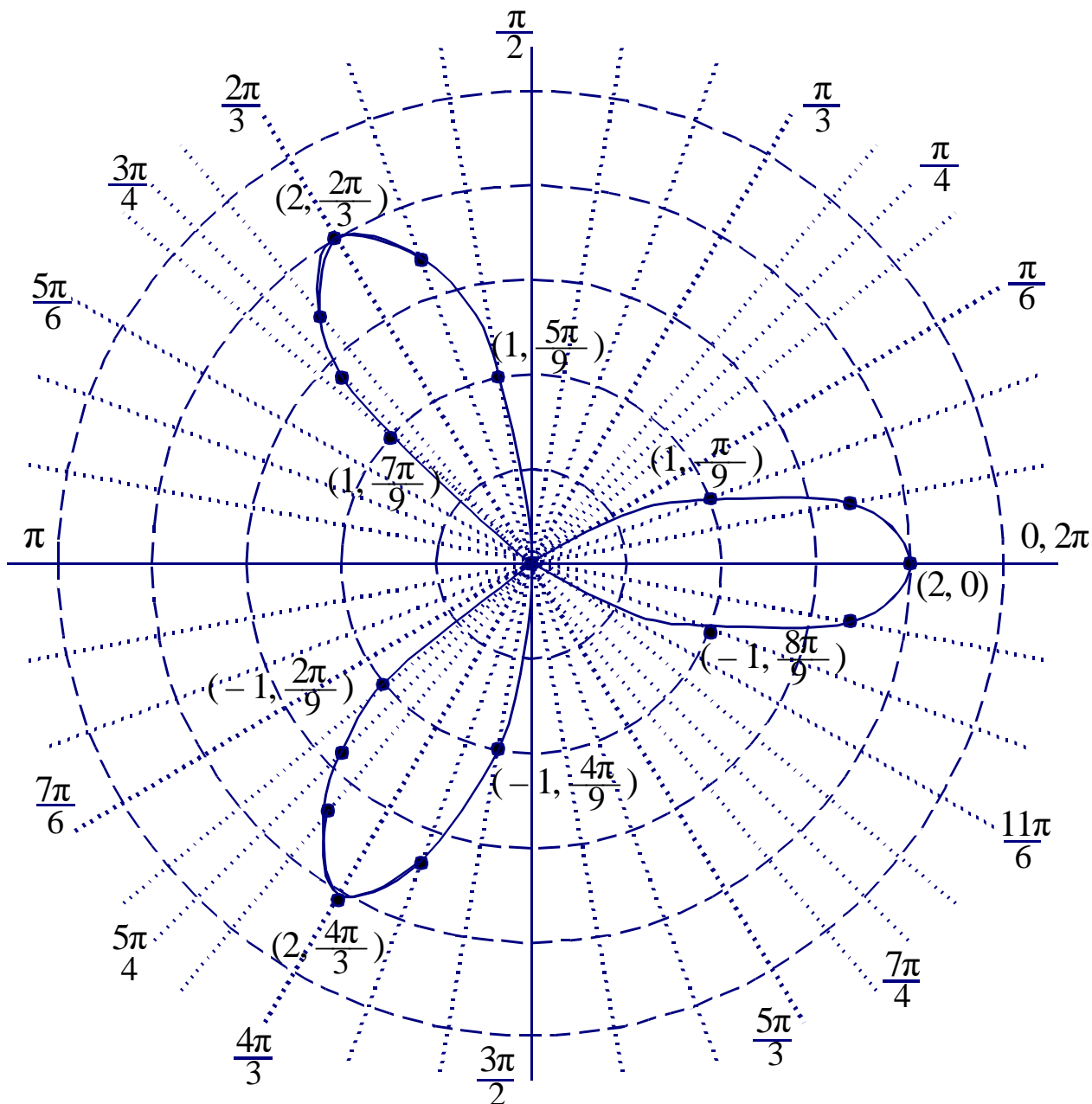
The values in the columns on the right produce points that are duplicates of the points that come from the values in the columns on the left.



7.  $r = 2 \cos(3\theta)$  Plot using “Polar Grid to use with sin/cos of 3 theta” on my website.

Plot only the points corresponding to the whole number multiples of  $\theta = \frac{\pi}{18}$ , for  $0 \leq \theta \leq \pi$

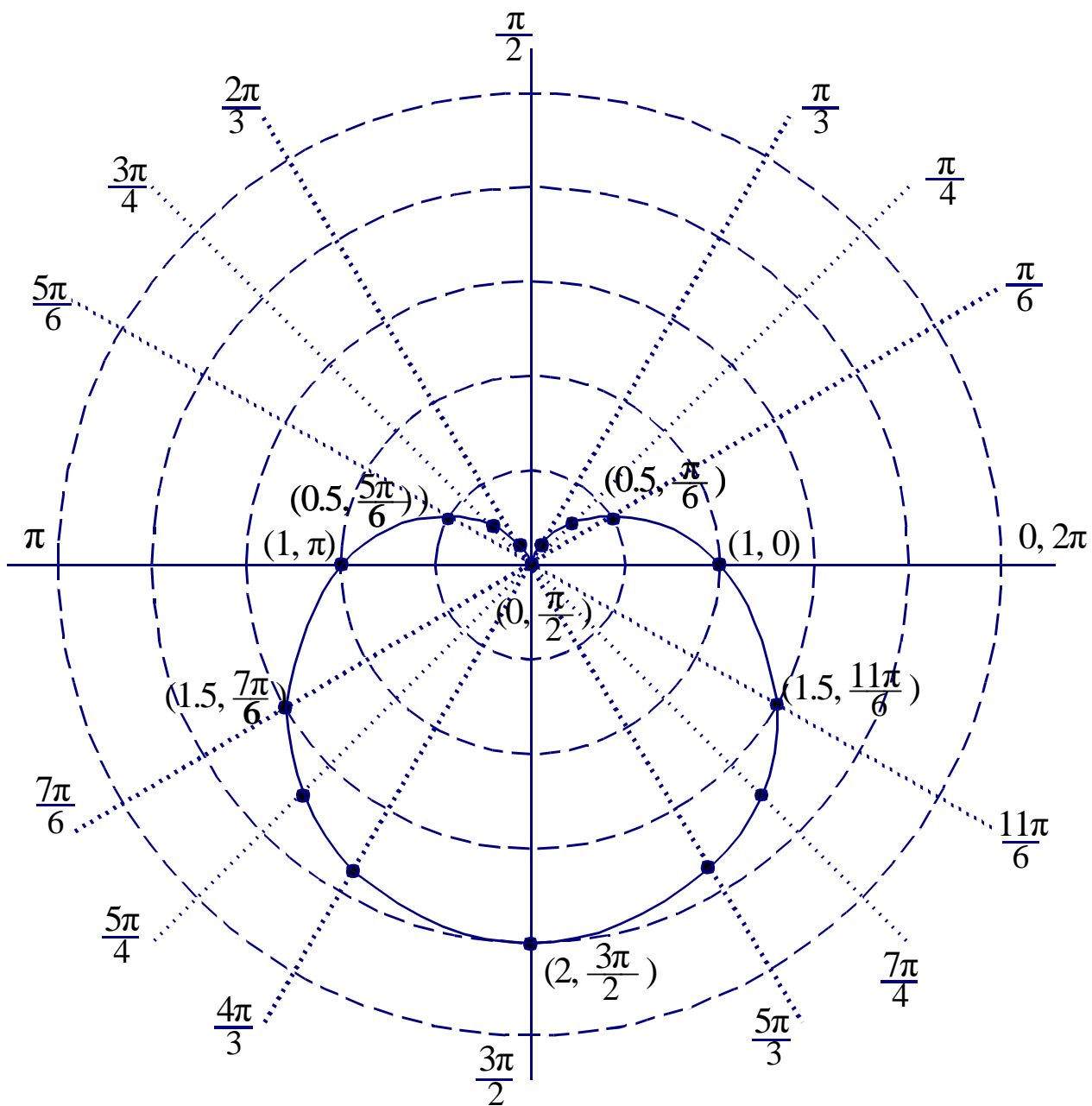
$\theta =$	$r = 2 \cos(3\theta)$		$\theta =$	$r = 2 \cos(3\theta)$		$\theta =$	$r = 2 \cos(3\theta)$
0	$2 \cos(0) = 2$						
$\frac{\pi}{18}$	$2 \cos\left(\frac{\pi}{6}\right) = \sqrt{3}$		$\frac{7\pi}{18}$	$2 \cos\left(\frac{7\pi}{6}\right) = -\sqrt{3}$		$\frac{13\pi}{18}$	$2 \cos\left(\frac{13\pi}{6}\right) = \sqrt{3}$
$\frac{\pi}{12}$	$2 \cos\left(\frac{\pi}{4}\right) = \sqrt{2}$		$\frac{5\pi}{12}$	$2 \cos\left(\frac{5\pi}{4}\right) = -\sqrt{2}$		$\frac{3\pi}{4}$	$2 \cos\left(\frac{9\pi}{4}\right) = \sqrt{2}$
$\frac{\pi}{9}$	$2 \cos\left(\frac{\pi}{3}\right) = 1$		$\frac{4\pi}{9}$	$2 \cos\left(\frac{4\pi}{3}\right) = -1$		$\frac{7\pi}{9}$	$2 \cos\left(\frac{7\pi}{3}\right) = 1$
$\frac{\pi}{6}$	$2 \cos\left(\frac{\pi}{2}\right) = 0$		$\frac{\pi}{2}$	$2 \cos\left(\frac{3\pi}{2}\right) = 0$		$\frac{5\pi}{6}$	$2 \cos\left(\frac{5\pi}{2}\right) = 0$
$\frac{2\pi}{9}$	$2 \cos\left(\frac{2\pi}{3}\right) = -1$		$\frac{5\pi}{9}$	$2 \cos\left(\frac{5\pi}{3}\right) = 1$		$\frac{8\pi}{9}$	$2 \cos\left(\frac{8\pi}{3}\right) = -1$
$\frac{\pi}{4}$	$2 \cos\left(\frac{3\pi}{4}\right) = -\sqrt{2}$		$\frac{7\pi}{12}$	$2 \cos\left(\frac{7\pi}{4}\right) = \sqrt{2}$		$\frac{11\pi}{12}$	$2 \cos\left(\frac{11\pi}{4}\right) = -\sqrt{2}$
$\frac{5\pi}{18}$	$2 \cos\left(\frac{5\pi}{6}\right) = -\sqrt{3}$		$\frac{11\pi}{18}$	$2 \cos\left(\frac{11\pi}{6}\right) = \sqrt{3}$		$\frac{17\pi}{18}$	$2 \cos\left(\frac{17\pi}{6}\right) = -\sqrt{3}$
$\frac{\pi}{3}$	$2 \cos(\pi) = -2$		$\frac{2\pi}{3}$	$2 \cos(2\pi) = 2$		$\pi$	$2 \cos(3\pi) = -2$



8.  $r = 1 - \sin(\theta)$

We plot a table of  $(r, \theta)$  values:

$\theta =$	$r = 1 - \sin(\theta)$		$\theta =$	$r = 1 - \sin(\theta)$
0	$1 - \sin(0) = 1$			
$\frac{\pi}{6}$	$1 - \sin\left(\frac{\pi}{6}\right) = 0.5$		$\frac{7\pi}{6}$	$1 - \sin\left(\frac{7\pi}{6}\right) = 1.5$
$\frac{\pi}{4}$	$1 - \sin\left(\frac{\pi}{4}\right) = 0.3$		$\frac{5\pi}{4}$	$1 - \sin\left(\frac{5\pi}{4}\right) = 1.7$
$\frac{\pi}{3}$	$1 - \sin\left(\frac{\pi}{3}\right) = 0.135$		$\frac{4\pi}{3}$	$1 - \sin\left(\frac{4\pi}{3}\right) = 1.865$
$\frac{\pi}{2}$	$1 - \sin\left(\frac{\pi}{2}\right) = 0$		$\frac{3\pi}{2}$	$1 - \sin\left(\frac{3\pi}{2}\right) = 2$
$\frac{2\pi}{3}$	$1 - \sin\left(\frac{2\pi}{3}\right) = 0.135$		$\frac{5\pi}{3}$	$1 - \sin\left(\frac{5\pi}{3}\right) = 1.865$
$\frac{3\pi}{4}$	$1 - \sin\left(\frac{3\pi}{4}\right) = 0.3$		$\frac{7\pi}{4}$	$1 - \sin\left(\frac{7\pi}{4}\right) = 1.7$
$\frac{5\pi}{6}$	$1 - \sin\left(\frac{5\pi}{6}\right) = 0.5$		$\frac{11\pi}{6}$	$1 - \sin\left(\frac{11\pi}{6}\right) = 1.5$
$\pi$	$1 - \sin(\pi) = 1$		$2\pi$	$1 - \sin(2\pi) = 0$

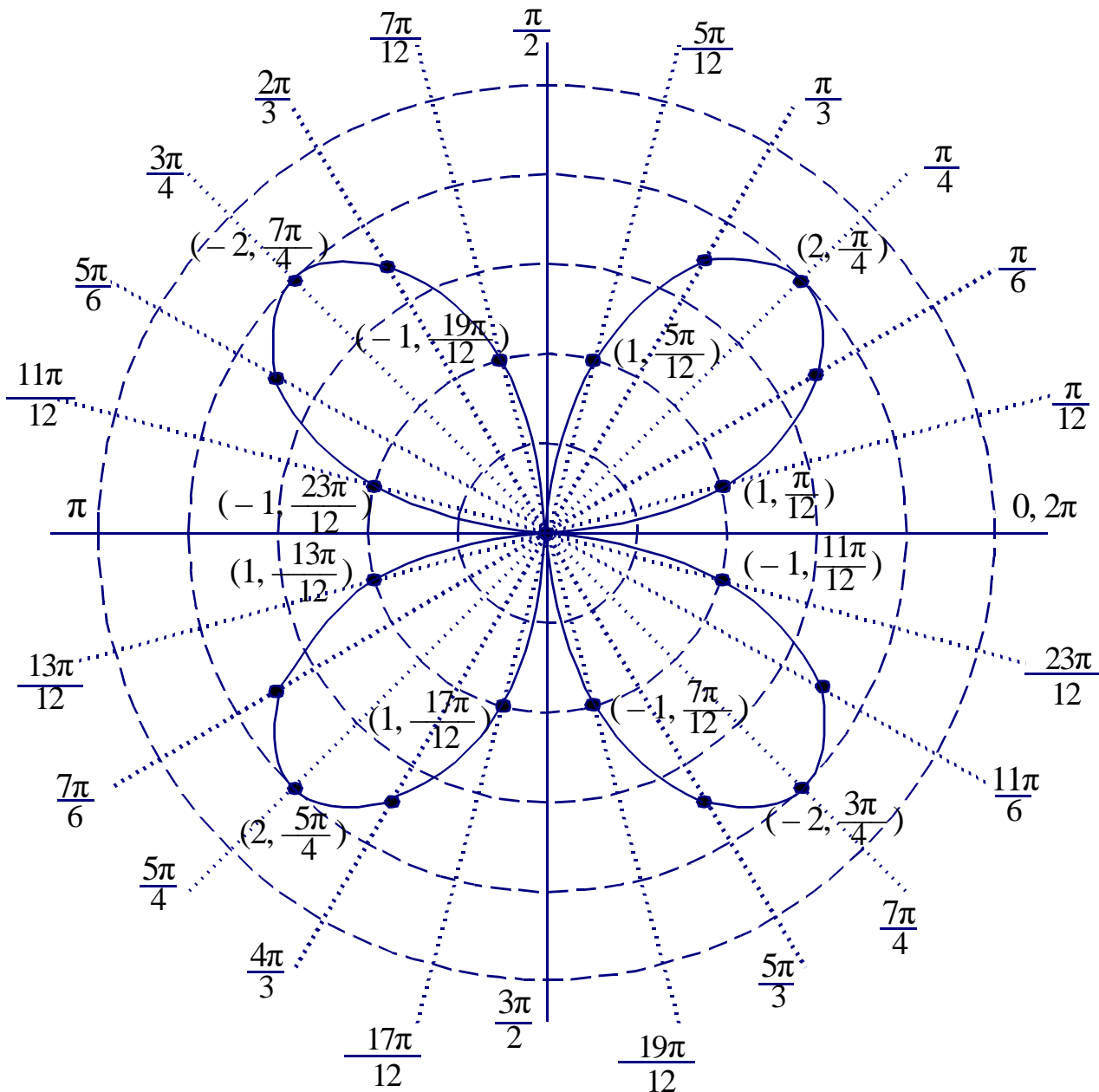




9.  $r = 2 \sin(2\theta)$  Plot using “Polar Grid to use with sin/cos of 2 theta” on my website.

Plot only the points corresponding to the whole number multiples of  $\theta = \frac{\pi}{12}$ , for  $0 \leq \theta \leq 2\pi$

$\theta =$	$r = 2 \sin(2\theta)$	$\theta =$	$r = 2 \sin(2\theta)$	$\theta =$	$r = 2 \sin(2\theta)$
0	$2 \sin(0) = 0$				
$\frac{\pi}{12}$	$2 \sin\left(\frac{\pi}{6}\right) = 1$	$\frac{3\pi}{4}$	$2 \sin\left(\frac{3\pi}{2}\right) = -2$	$\frac{17\pi}{12}$	$2 \sin\left(\frac{17\pi}{6}\right) = 1$
$\frac{\pi}{6}$	$2 \sin\left(\frac{\pi}{3}\right) = 1.73$	$\frac{5\pi}{6}$	$2 \sin\left(\frac{5\pi}{3}\right) = -1.73$	$\frac{3\pi}{2}$	$2 \sin(3\pi) = 0$
$\frac{\pi}{4}$	$2 \sin\left(\frac{\pi}{2}\right) = 2$	$\frac{11\pi}{12}$	$2 \sin\left(\frac{11\pi}{6}\right) = -1$	$\frac{19\pi}{12}$	$2 \sin\left(\frac{19\pi}{6}\right) = -1$
$\frac{\pi}{3}$	$2 \sin\left(\frac{2\pi}{3}\right) = 1.73$	$\pi$	$2 \sin(2\pi) = 0$	$\frac{5\pi}{3}$	$2 \sin\left(\frac{10\pi}{3}\right) = -1.73$
$\frac{5\pi}{12}$	$2 \sin\left(\frac{5\pi}{6}\right) = 1$	$\frac{13\pi}{12}$	$2 \sin\left(\frac{13\pi}{6}\right) = 1$	$\frac{7\pi}{4}$	$2 \sin\left(\frac{7\pi}{2}\right) = -2$
$\frac{\pi}{2}$	$2 \sin(\pi) = 0$	$\frac{7\pi}{6}$	$2 \sin\left(\frac{7\pi}{3}\right) = 1.73$	$\frac{11\pi}{6}$	$2 \sin\left(\frac{11\pi}{3}\right) = -1.73$
$\frac{7\pi}{12}$	$2 \sin\left(\frac{7\pi}{6}\right) = -1$	$\frac{5\pi}{4}$	$2 \sin\left(\frac{5\pi}{2}\right) = 2$	$\frac{23\pi}{12}$	$2 \sin\left(\frac{23\pi}{6}\right) = -1$
$\frac{2\pi}{3}$	$2 \sin\left(\frac{4\pi}{3}\right) = -1.73$	$\frac{4\pi}{3}$	$2 \sin\left(\frac{8\pi}{3}\right) = 1.73$	$2\pi$	$2 \sin(4\pi) = 0$



10.  $r = 3 + 2 \sin(\theta)$

We plot a table of  $(r, \theta)$  values:

$\theta =$	$r = 3 + 2 \sin(\theta)$	$\theta =$	$r = 3 + 2 \sin(\theta)$
0	$3 + 2 \sin(0) = 3$		
$\frac{\pi}{6}$	$3 + 2 \sin(\frac{\pi}{6}) = 4$	$\frac{7\pi}{6}$	$3 + 2 \sin(\frac{7\pi}{6}) = 2$
$\frac{\pi}{4}$	$3 + 2 \sin(\frac{\pi}{4}) = 4.4$	$\frac{5\pi}{4}$	$3 + 2 \sin(\frac{5\pi}{4}) = 1.6$
$\frac{\pi}{3}$	$3 + 2 \sin(\frac{\pi}{3}) = 4.7$	$\frac{4\pi}{3}$	$3 + 2 \sin(\frac{4\pi}{3}) = 1.3$
$\frac{\pi}{2}$	$3 + 2 \sin(\frac{\pi}{2}) = 5$	$\frac{3\pi}{2}$	$3 + 2 \sin(\frac{3\pi}{2}) = 1$
$\frac{2\pi}{3}$	$3 + 2 \sin(\frac{2\pi}{3}) = 4.7$	$\frac{5\pi}{3}$	$3 + 2 \sin(\frac{5\pi}{3}) = 1.3$
$\frac{3\pi}{4}$	$3 + 2 \sin(\frac{3\pi}{4}) = 4.4$	$\frac{7\pi}{4}$	$3 + 2 \sin(\frac{7\pi}{4}) = 1.6$
$\frac{5\pi}{6}$	$3 + 2 \sin(\frac{5\pi}{6}) = 4$	$\frac{11\pi}{6}$	$3 + 2 \sin(\frac{11\pi}{6}) = 2$
$\pi$	$3 + 2 \sin(\pi) = 3$	$2\pi$	$3 + 2 \sin(2\pi) = 3$

