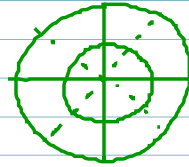


Polar Grid



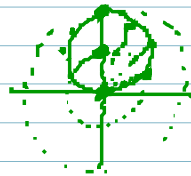
Polar Equations

$r \cos(\theta) = a \rightarrow x = a$ Vertical Line
 $r \sin(\theta) = a \rightarrow y = a$ Horizontal Line

$a > 0$

$r = 2a \sin(\theta) \rightarrow c = (0, a)$
 $r = -2a \sin(\theta) \rightarrow c = (0, -a)$
 $r = 2a \cos(\theta) \rightarrow c = (a, 0)$
 $r = -2a \cos(\theta) \rightarrow c = (-a, 0)$

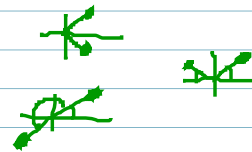
$r = 2 \sin(\theta)$



θ	r
0	0
$\pi/6$	1
$\pi/4$	$\sqrt{2} = 1.414$
$\pi/3$	$\sqrt{3} = 1.732$
$\pi/2$	2
π	0

symmetry

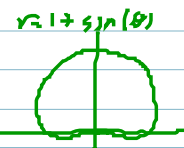
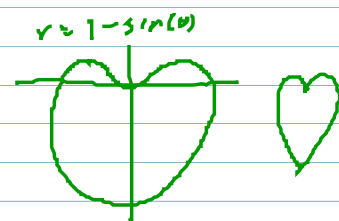
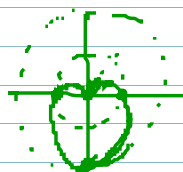
Polar Axis - x-axis $\rightarrow r(-\theta) = r(\theta)$
Line $\theta = \pi/2$ - y-axis $\rightarrow r(\pi - \theta) = r(\theta)$
Pole - origin $\rightarrow r(\pi + \theta) = r(\theta)$



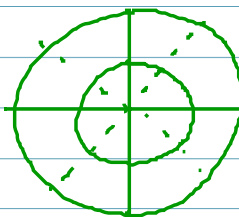
Cardioid - $r = a(1 \pm \cos(\theta))$ $a > 0$
 $r = a(1 \pm \sin(\theta))$

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

θ	r
0	1
$\pi/6$	$\frac{1}{2}$
$\pi/4$	$1 - \frac{\sqrt{2}}{2} = 0.293$
$\pi/3$	$1 - \frac{\sqrt{3}}{2} = 0.14$
$\pi/2$	0
π	1
$3\pi/2$	2
2π	1



Polar Grid



Polar Equations

$$r \cos(\theta) = a \rightarrow x = a \quad \text{Vertical Line}$$

$$r \sin(\theta) = a \rightarrow y = a \quad \text{Horizontal Line}$$

$a > 0$

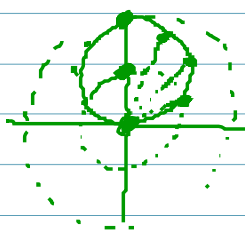
$$r = 2a \sin(\theta) \rightarrow c = (0, a)$$

$$r = -2a \sin(\theta) \rightarrow c = (0, -a)$$

$$r = 2a \cos(\theta) \rightarrow c = (a, 0)$$

$$r = -2a \cos(\theta) \rightarrow c = (-a, 0)$$

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



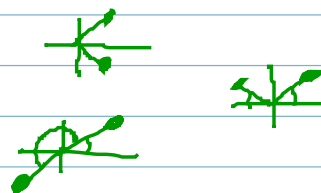
θ	r
0	0
$\pi/6$	1
$\pi/4$	$\sqrt{2} = 1.414$
$\pi/3$	$\sqrt{3} = 1.732$
$\pi/2$	2
π	0

Symmetry

Polar Axis - x-axis $\rightarrow r(-\theta) = r(\theta)$

Line $\theta = \frac{\pi}{2}$ - y-axis $\rightarrow r(\pi - \theta) = r(\theta)$

Pole - origin $\rightarrow r(\pi + \theta) = r(\theta)$

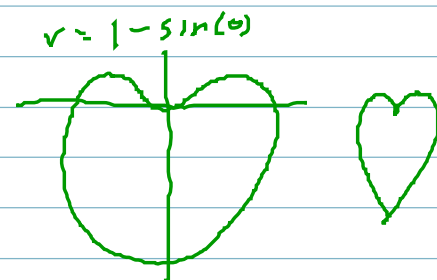
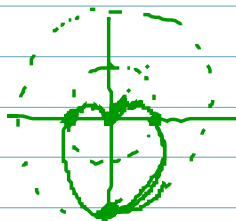


Cardioid - $r = a(1 \pm \cos(\theta))$ $a > 0$

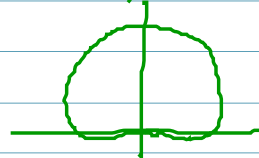
$$r = a(1 \pm \sin(\theta))$$

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

θ	r
0	1
$\pi/6$	$\frac{1}{2}$
$\pi/4$	$1 - \frac{\sqrt{2}}{2} = 0.293$
$\pi/3$	$1 - \frac{\sqrt{3}}{2} = 0.14$
$\pi/2$	0
π	1
$\frac{3\pi}{2}$	2
2π	1



$$r = 1 + \sin(\theta)$$

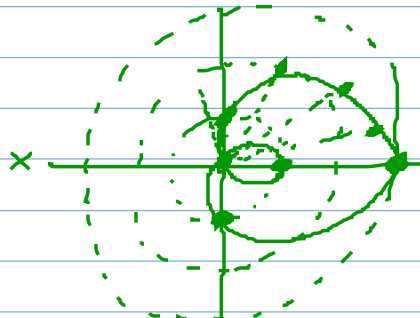


Limacon w/ ~~inner~~ inner loop

$r = a \pm b \cos(\theta)$

$r = a \pm b \sin(\theta), 0 < \cancel{a} < b$
 $a < b$

θ	r	$r = 1 + 2 \cos(\theta)$
0	3	
$\pi/6$	$1 + \sqrt{3} = 2.73$	
$\pi/4$	$1 + \sqrt{2} = 2.414$	
$\pi/3$	2	
$\pi/2$	1	
π	-1	
$3\pi/2$	1	
2π	3	
$2\pi/3$	0	



Limacon w/out inner loop

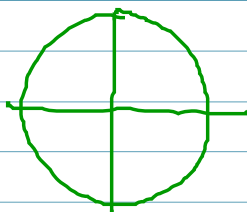
$r = a \pm b \cos(\theta)$

$r = a \pm b \cos(\theta) \quad 0 < b < a$

θ	r	$r = 2 + \cos(\theta)$
0	3	
$\pi/6$	$2 + \frac{\sqrt{3}}{2} = 2.86$	
$\pi/4$	$2 + \frac{\sqrt{2}}{2} = 2.707$	
$\pi/3$	2.5	
$\pi/2$	2	
π	1	
$3\pi/2$	2	
2π	3	



$r = a$



$0 < b < a$

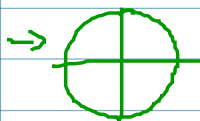
$r = a \pm b \cos(\theta)$

~~$r = a$~~

$r = a(1 \pm \cos(\theta))$

$0 < a < b$

$r = a \pm b \cos(\theta)$

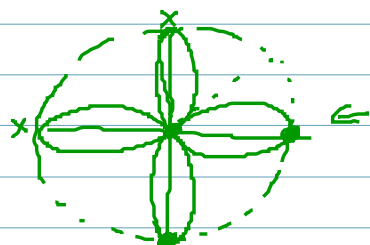


$r = 2b \cos(\theta)$

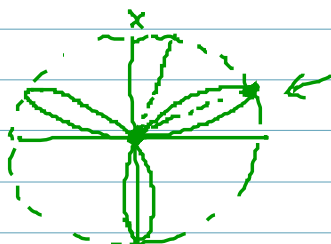


Rose - $r = a \cos(n\theta)$ $a \neq 0$ $n = \text{even}$, $2n$ Petals
 $r = a \sin(n\theta)$ $n = \text{odd}$, n Petals
 $n \in \mathbb{Z}$

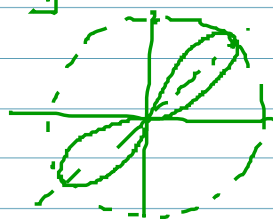
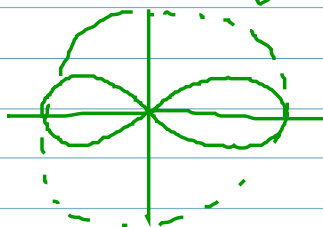
$r = \cos(2\theta)$



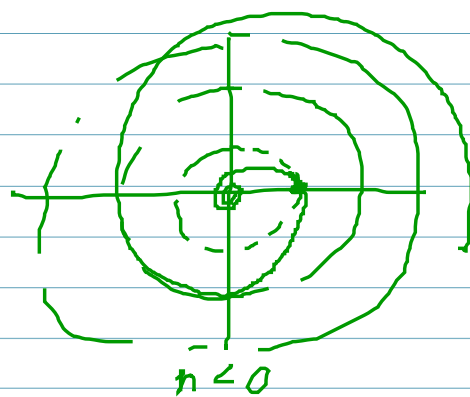
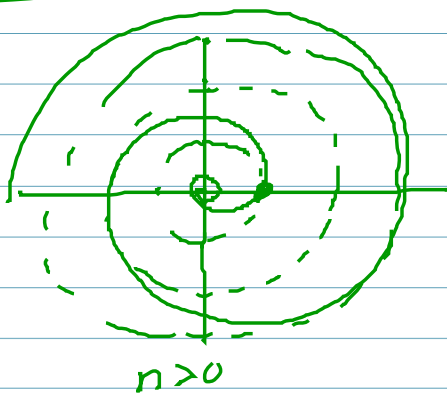
$r = \sin(3\theta)$



Lemniscate - $r^2 = a^2 \cos(2\theta)$ $a \neq 0$
 $r^2 = a^2 \sin(2\theta)$



Logarithmic Spiral - $r = e^{a\theta/n}$ $n \neq 0$



$\theta = a$

