

## Happy National Mr. Potato Head Day!

- Park your phones
- Grab calculators
- Take out HW from last night
- Start warmup on circle table



*Did you take AP Survey?*

Honors Pre-Calculus

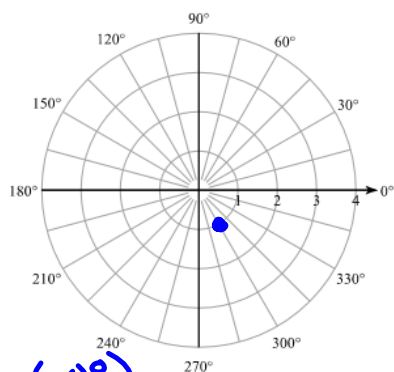
Name \_\_\_\_\_

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Polar Warmup

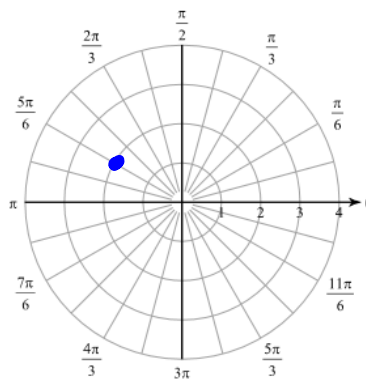
Plot the point with the given polar coordinates. Then, give the other 3 names for each point

1)  $(1, 300^\circ)$



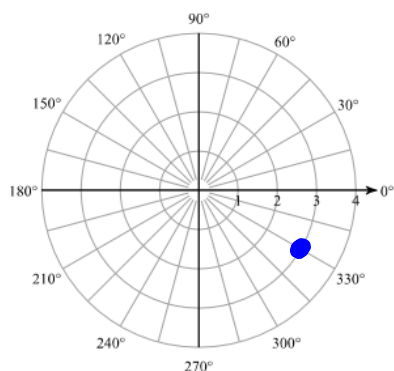
$(1, -60^\circ)$   
 $(-1, 120^\circ)$   
 $(-1, -240^\circ)$

2)  $(2, \frac{5\pi}{6})$



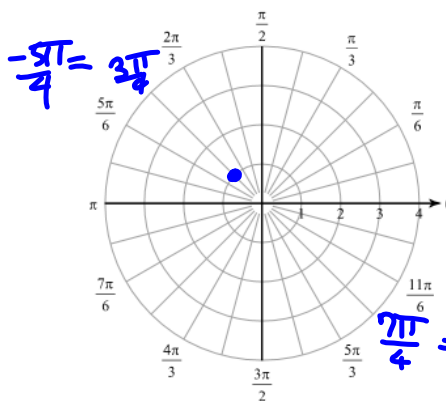
$(2, -\frac{7\pi}{6})$   $(-2, \frac{11\pi}{6})$   
 $(-2, \frac{\pi}{6})$

3)  $(3, -30^\circ)$



$(3, 330^\circ)$   
 $(-3, 150^\circ)$   
 $(-3, -210^\circ)$

4)  $(-1, \frac{7\pi}{4})$



$-\frac{7\pi}{4} = \frac{9\pi}{4}$   
 $\frac{9\pi}{4} = -\frac{\pi}{4}$

$(1, \frac{3\pi}{4})$   
 $(-1, -\frac{\pi}{4})$   
 $(1, -\frac{5\pi}{4})$

Convert each pair of polar coordinates to rectangular coordinates.

$$5) \left(-2, \frac{3\pi}{2}\right) = (0, 2)$$

$$6) (-4, 225^\circ) = (2\sqrt{2}, 2\sqrt{2})$$

$$x = r \cos \theta$$

$$x = -2 \cos\left(\frac{3\pi}{2}\right)$$

$$= -2 \cdot 0$$

$$x = 0$$

$$y = r \cdot \sin \theta$$

$$= -2 \sin\left(\frac{3\pi}{2}\right)$$

$$= -2 \cdot -1$$

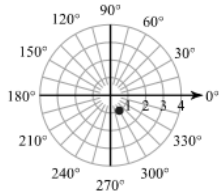
$$y = 2$$

$$7) (-1, 60^\circ) = \left(-\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$$

$$8) \left(3, \frac{11\pi}{6}\right) = \left(\frac{3\sqrt{3}}{2}, -\frac{3}{2}\right)$$

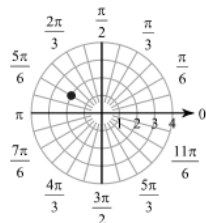
Answers to Polar Warmup

1)



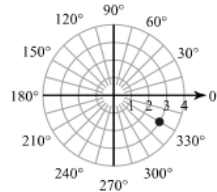
5)  $(0, 2)$

2)



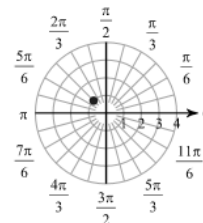
6)  $(2\sqrt{2}, 2\sqrt{2})$

3)



7)  $\left(-\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$

4)



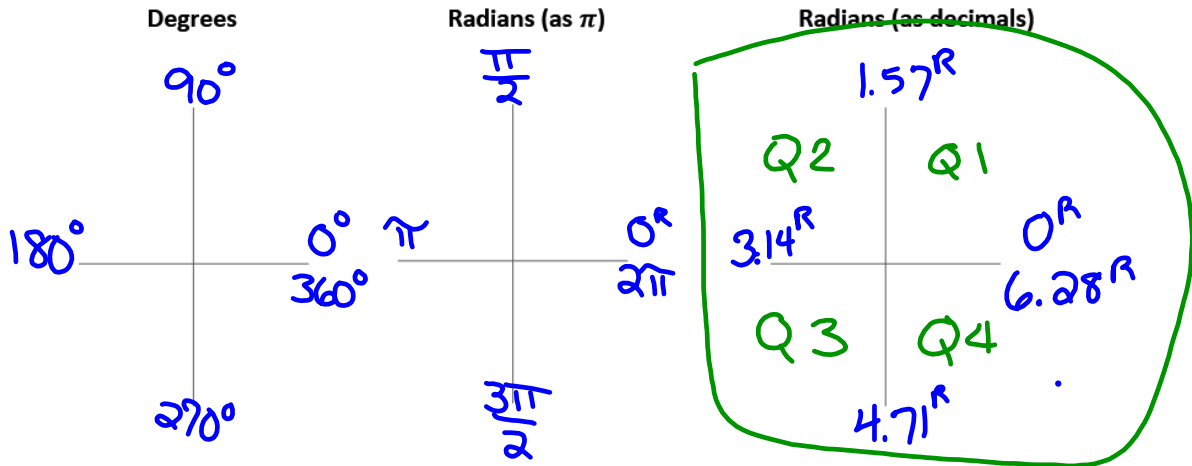
8)  $\left(\frac{3\sqrt{3}}{2}, -\frac{3}{2}\right)$

Degrees and Radians Review

Put your calculator in radians, solve for  $\theta$

1.  $\cos(\theta) + 1 = 0$   
 $\cos^{-1}(\cos(\theta) = -1)$   
 $\theta = \cos^{-1}(-1)$

$\theta = \pi \rightarrow$  Radian  
 $\theta = 3.14^R \rightarrow$  Radian  
 Decimals



What quadrant do the following angles lie?

- $247^\circ$       $\frac{7\pi}{8}$  <sup>off from x-axis</sup>      $5.5^R$       $2.25^R$       $1.4^R$       $3.87^R$       $\frac{12\pi}{7}$   
 3     2     4     2     1     3     4

Put your calculator in degrees, solve for  $\theta$

$5\cos(\theta) + 2 = 0$   
 $\cos^{-1}(\cos\theta = -\frac{2}{5})$   
 $\theta = \cos^{-1}(-\frac{2}{5})$

$Q2 = 113.58^\circ$   
 $Q3 = 246.42^\circ$   
 cos is neg.  
 Q2  
 Q3  
 Ref angle  
 $-180$   
 $113.58^\circ$   
 $\hline$   
 $-66.42^\circ$   
 Ref angle  $\rightarrow$   
 $+180$   
 $+66.42^\circ$

Put your calculator in radians, solve for  $\theta$

$3\tan(\theta) - 8 = 0$   
 $\tan^{-1}(\tan\theta = \frac{8}{3})$   
 $\theta = \tan^{-1}(\frac{8}{3})$

$Q1 = 1.21^R$   
 $Q3 = 4.35^R$   
 Ref angle b/c in Q1  
 $1.21^R$   
 $+3.14^R$   


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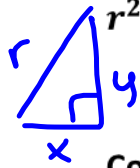
 Tan  
 Pos  
 Q1 &  
 Q3

\*If you "know" the Ratio  $\Rightarrow$  give radians in terms of  $\pi$

Conversion Formulas:

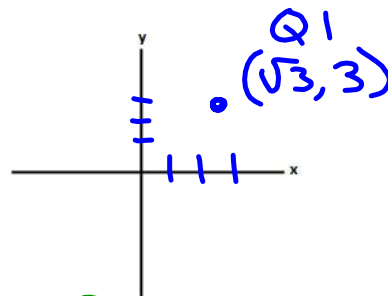
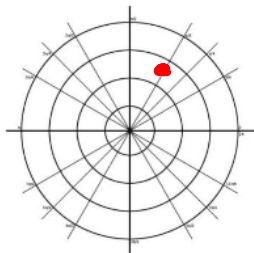
$x = r \cdot \cos\theta$   $y = r \cdot \sin\theta$  ← Polar → Rectangular

Pythagorean  $r^2 = x^2 + y^2$  and  $\tan(\theta) = \frac{y}{x}$  ← Rectangular → Polar



Convert the point  $(\sqrt{3}, 3)$  from rectangular to polar  
 $\approx 1.7$   
 (use degrees and radians)

$(r, \theta)$  1. Radius  
 2.  $\theta$



$r^2 = x^2 + y^2$   
 $r^2 = (\sqrt{3})^2 + (3)^2$   
 $r^2 = 3 + 9$   
 $r^2 = 12$   
 $r = \pm 2\sqrt{3}$

$\tan\theta = \frac{3}{\sqrt{3}} = \sqrt{3}$   
 $\theta = \tan^{-1}(\sqrt{3})$

$\theta = \frac{\pi}{3}$  &  $\frac{4\pi}{3}$

$(2\sqrt{3}, \frac{\pi}{3})$   
 Q1 angle

$(-2\sqrt{3}, \frac{4\pi}{3})$   
 Q3 angle

Bonus

$(2\sqrt{3}, -\frac{2\pi}{3})$

$(2\sqrt{3}, -\frac{5\pi}{3})$

$(x, y)$   $(r, \theta)$

Convert the point  $(-3, 4)$  from rectangular to polar, then plot both points: (use degrees and radians)

$$\begin{array}{r} 6.28R \\ + -.93R \\ \hline 5.35R \end{array}$$

$$\begin{aligned} \tan^{-1} \\ \left( \tan \theta = \frac{4}{-3} \right) \\ \theta = \tan^{-1} \left( -\frac{4}{3} \right) \\ \theta = -.93R \end{aligned}$$

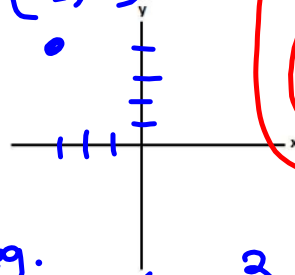
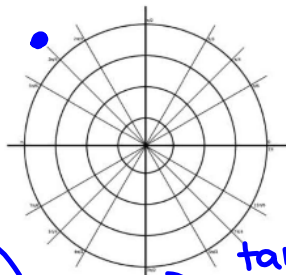
$.93R \rightarrow$  ref angle

tan is neg.  
Q2 & Q4  
2.21R 5.35R

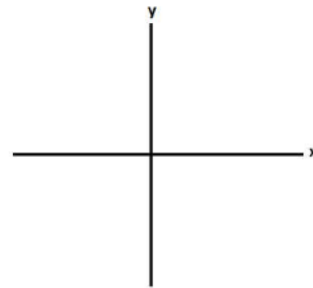
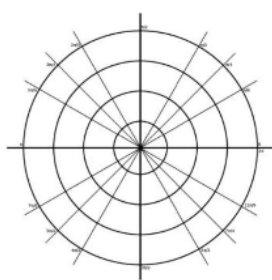
$$\frac{-3.14}{.93R}$$

$$\begin{aligned} x^2 + y^2 &= r^2 \\ (-3)^2 + (4)^2 &= r^2 \\ 9 + 16 &= r^2 \\ \sqrt{25} &= \sqrt{r^2} \\ r &= 5 \end{aligned}$$

$(5, 2.21R)$   
 $(-5, 5.35R)$



Convert the point  $(5, -5)$  from rectangular to polar, then plot the points (use degrees and radians)

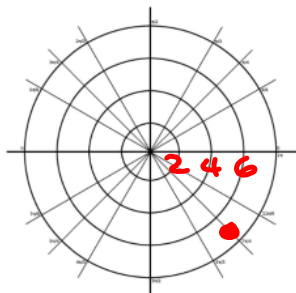


Polar vs Rectangular Coordinates

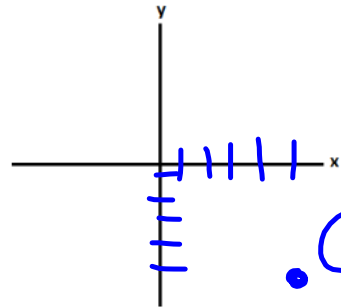
$(x, y)$   $(r, \theta)$

Convert the point (5, -5) from rectangular to polar, then plot the points (use degrees and radians)

$\tan \theta = \frac{-5}{5}$   
 $\theta = \tan^{-1}(-1)$   
 Q2      Q4  
 $\frac{3\pi}{4}$      $\frac{7\pi}{4}$   
 $r^2 = x^2 + y^2$   
 $r = \pm 5\sqrt{2}$

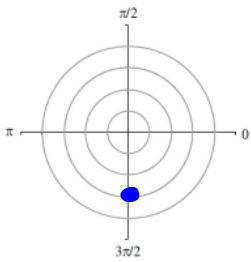


$(5\sqrt{2}, \frac{7\pi}{4})$

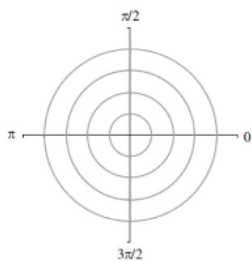


$(-5\sqrt{2}, \frac{3\pi}{4})$

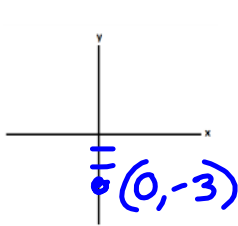
Convert  $(0, -3)$  to polar  $(3, \frac{3\pi}{2})$



Convert  $(2, 0)$  to polar  $(2, 0)$

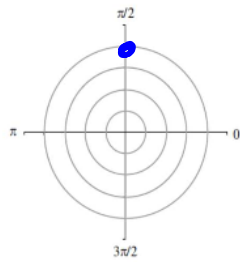


Convert  $(0, 4)$  to polar  $(4, \frac{\pi}{2})$

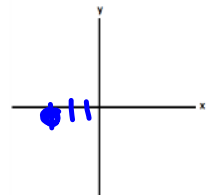
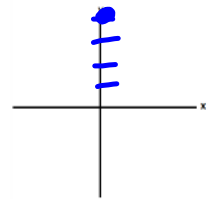
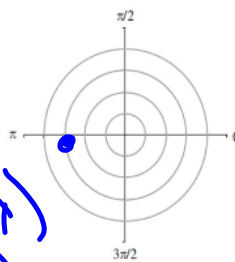


$(-2, \pi)$   
 $(2, 0)$

$(2, -2\pi)$   
 $(-2, -\pi)$



Convert  $(-3, 0)$  to polar  $(3, \pi)$





Polar vs Rectangular Coordinates

**Find the polar coordinates (in radians) of each point given the following rectangular coordinates.**

1.  $(2, 2)$

2.  $(2, -3)$

3.  $(-3, \sqrt{3})$

4.  $(-5, -8)$

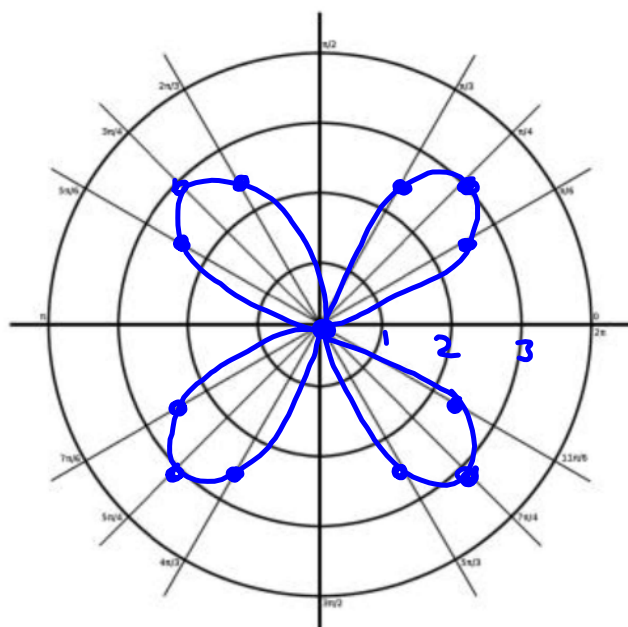
Graph  $r = 3\sin(2\theta)$

(Rose Curve)

$\theta$	$r$
0	0
$\frac{\pi}{6}$	2.6
$\frac{\pi}{3}$	2.6
$\frac{\pi}{2}$	0
$\frac{2\pi}{3}$	-2.6
$\frac{5\pi}{6}$	-2.6
$\pi$	0
$\frac{7\pi}{6}$	2.6
$\frac{4\pi}{3}$	2.6
$\frac{3\pi}{2}$	0
$\frac{5\pi}{3}$	-2.6
$\frac{11\pi}{6}$	-2.6
$2\pi$	0

$3\sin(2 \cdot 0)$

$3\sin(2 \cdot \frac{\pi}{6}) \Rightarrow 3 \cdot \sin(\frac{\pi}{3}) = \frac{3\sqrt{3}}{2}$

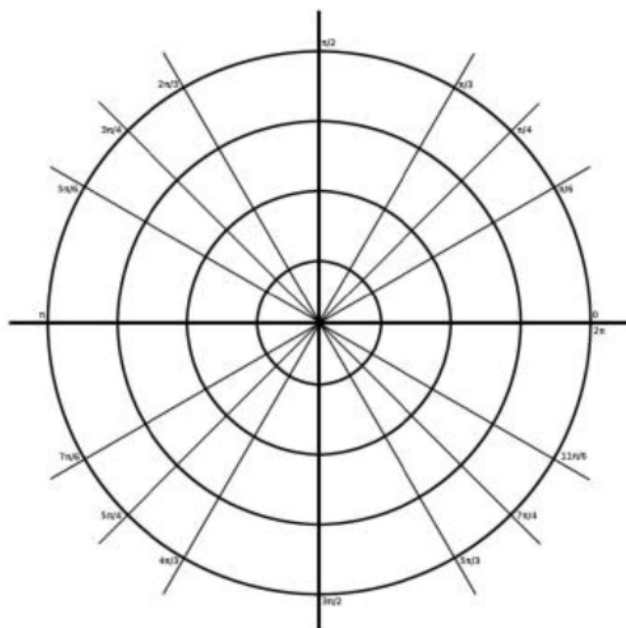


$\theta = \frac{\pi}{4} \quad r = 3$   
 $\theta = \frac{3\pi}{4} \quad r = -3$   
 $\theta = \frac{5\pi}{4} \quad r = 3$   
 $\theta = \frac{7\pi}{4} \quad r = -3$

Graph  $r = 2 + 2\sin\theta$

(Cardioid)

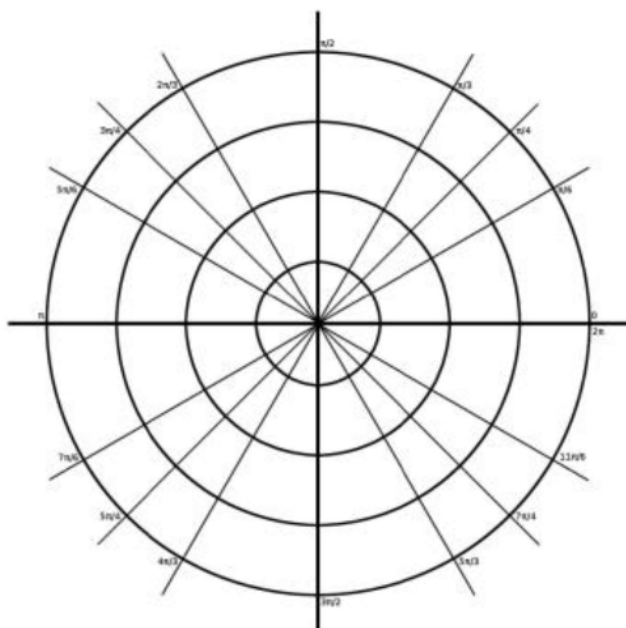
$\theta$	r
0	
$\frac{\pi}{6}$	
$\frac{\pi}{3}$	
$\frac{\pi}{2}$	
$\frac{2\pi}{3}$	
$\frac{5\pi}{6}$	
$\pi$	
$\frac{7\pi}{6}$	
$\frac{4\pi}{3}$	
$\frac{3\pi}{2}$	
$\frac{5\pi}{3}$	
$\frac{11\pi}{6}$	
$2\pi$	



Graph  $r = 5 - 3\cos\theta$ 

(Dimpled Limaçon)

$\theta$	$r$
0	
$\frac{\pi}{6}$	
$\frac{\pi}{3}$	
$\frac{\pi}{2}$	
$\frac{2\pi}{3}$	
$\frac{5\pi}{6}$	
$\pi$	
$\frac{7\pi}{6}$	
$\frac{4\pi}{3}$	
$\frac{3\pi}{2}$	
$\frac{5\pi}{3}$	
$\frac{11\pi}{6}$	
$2\pi$	



Graph  $r = 3 - 5\cos\theta$

(Limaçon with an inner loop)

$\theta$	$r$
0	
$\frac{\pi}{6}$	
$\frac{\pi}{3}$	
$\frac{\pi}{2}$	
$\frac{2\pi}{3}$	
$\frac{5\pi}{6}$	
$\pi$	
$\frac{7\pi}{6}$	
$\frac{4\pi}{3}$	
$\frac{3\pi}{2}$	
$\frac{5\pi}{3}$	
$\frac{11\pi}{6}$	
$2\pi$	

