ONLINE WORKSHEET PACKAGE

PRE CALCULUS

UNIT CIRCLE

DR AHN MATH & LEARNING CENTER

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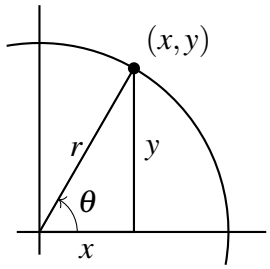
Trig Ratios of General Angles

- Using Circle and Terminal Side

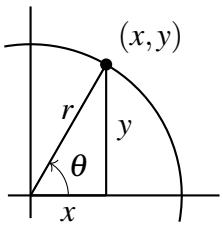


$$\sin\theta = \frac{y}{r}$$

$$\cos\theta = \frac{x}{r}$$

$$\tan\theta = \frac{y}{x}$$

- 1st Quadrant



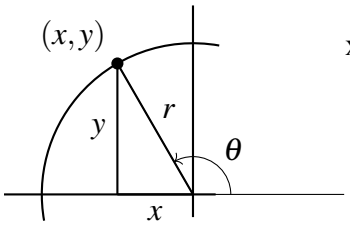
$x > 0, y > 0$

$\sin\theta > 0$

$\cos\theta > 0$

$\tan\theta > 0$

- 2nd Quadrant



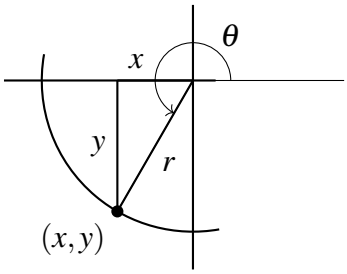
$x < 0, y > 0$

$\sin\theta > 0$

$\cos\theta < 0$

$\tan\theta < 0$

- 3rd Quadrant



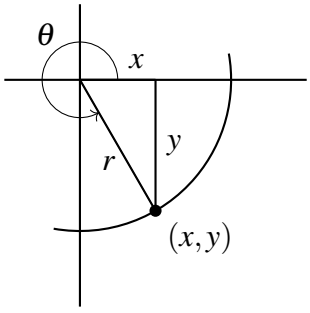
$x < 0, y < 0$

$\sin\theta < 0$

$\cos\theta < 0$

$\tan\theta > 0$

- 4th Quadrant



$x > 0, y < 0$

$\sin\theta < 0$

$\cos\theta > 0$

$\tan\theta < 0$

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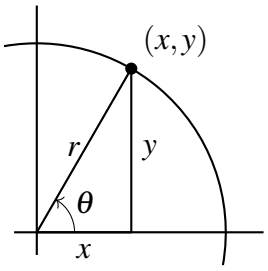
Trig Ratios of General Angles

- Using Circle and Terminal Side

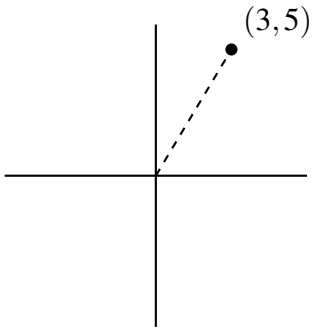


$$\sin\theta = \frac{y}{r} \qquad \csc\theta = \frac{1}{\sin\theta}$$

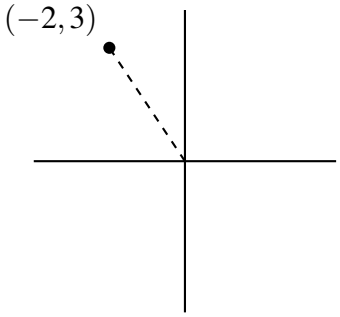
$$\cos\theta = \frac{x}{r} \qquad \sec\theta = \frac{1}{\cos\theta}$$

$$\tan\theta = \frac{y}{x} \qquad \cot\theta = \frac{1}{\tan\theta}$$

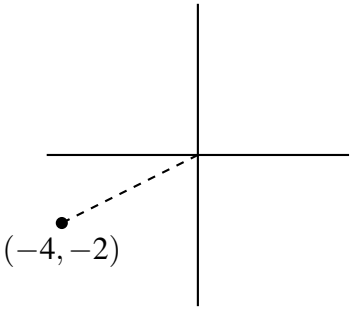
- 1st Quadrant



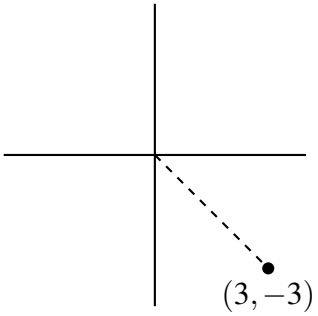
- 2nd Quadrant



- 3rd Quadrant



- 4th Quadrant



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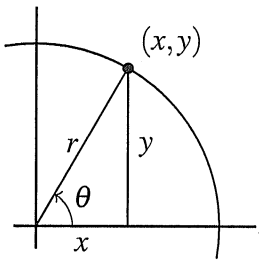
Trig Ratios of General Angles

- Using Circle and Terminal Side

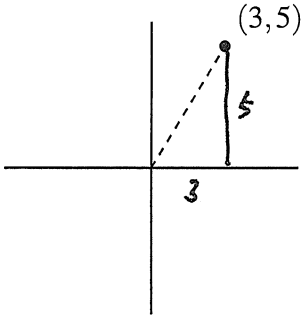


$$\sin\theta = \frac{y}{r} \qquad \csc\theta = \frac{1}{\sin\theta}$$

$$\cos\theta = \frac{x}{r} \qquad \sec\theta = \frac{1}{\cos\theta}$$

$$\tan\theta = \frac{y}{x} \qquad \cot\theta = \frac{1}{\tan\theta}$$

- 1st Quadrant



$r = \sqrt{9+25} = \sqrt{34}$

$\sin\theta = \frac{5}{\sqrt{34}} = \frac{5\sqrt{34}}{34}$

$\cos\theta = \frac{3}{\sqrt{34}} = \frac{3\sqrt{34}}{34}$

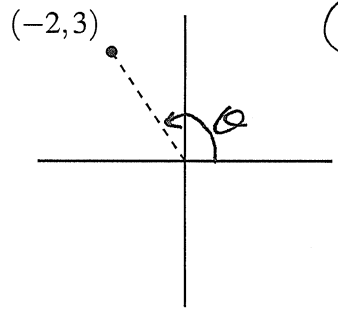
$\tan\theta = \frac{5}{3}$

$\csc\theta = \frac{\sqrt{34}}{5}$

$\sec\theta = \frac{\sqrt{34}}{3}$

$\cot\theta = \frac{3}{5}$

- 2nd Quadrant



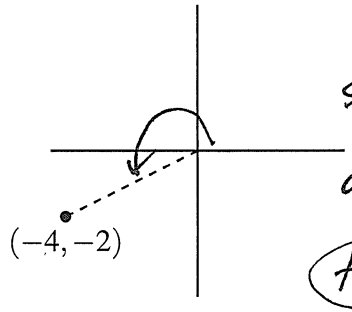
$r = \sqrt{4+9} = \sqrt{13}$

$\sin\theta = \frac{3}{\sqrt{13}} = \frac{3\sqrt{13}}{13}$

$\cos\theta = \frac{-2}{\sqrt{13}} = -\frac{2\sqrt{13}}{13}$

$\tan\theta = -\frac{3}{2}$

- 3rd Quadrant



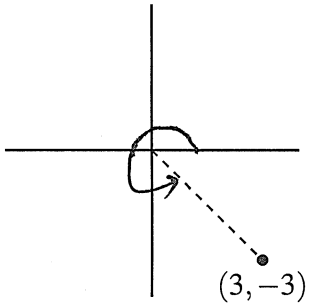
$r = \sqrt{16+4} = \sqrt{20} = 2\sqrt{5}$

$\sin\theta = \frac{-2}{2\sqrt{5}} = -\frac{\sqrt{5}}{5}$

$\cos\theta = \frac{-4}{2\sqrt{5}} = -\frac{2\sqrt{5}}{5}$

$\tan\theta = \frac{-2}{-4} = \frac{1}{2}$

- 4th Quadrant



$r = \sqrt{9+9} = 3\sqrt{2}$

$\sin\theta = \frac{-3}{3\sqrt{2}} = -\frac{\sqrt{2}}{2}$

$\cos\theta = \frac{3}{3\sqrt{2}} = \frac{\sqrt{2}}{2}$

$\tan\theta = \frac{-3}{3} = -1$

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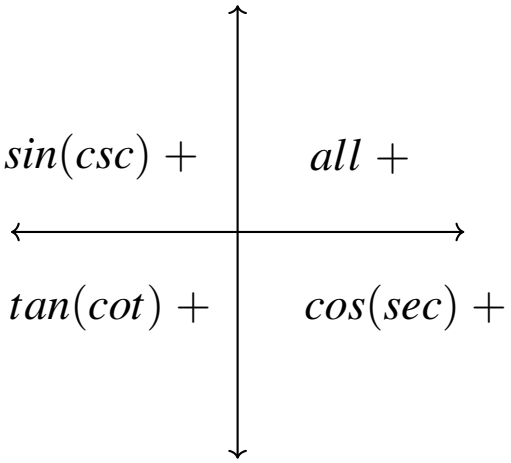
Trig Ratios of General Angles

- Given Ratio and Quadrant



$A\ S\ T\ C$

- $\sin\theta = \frac{2}{3},\ \cos\theta < 0 \quad \rightarrow \quad$ find $\sec\theta$

- $\cot\theta = -\frac{3}{4},\ \cos\theta > 0 \quad \rightarrow \quad$ find $\sin\theta$

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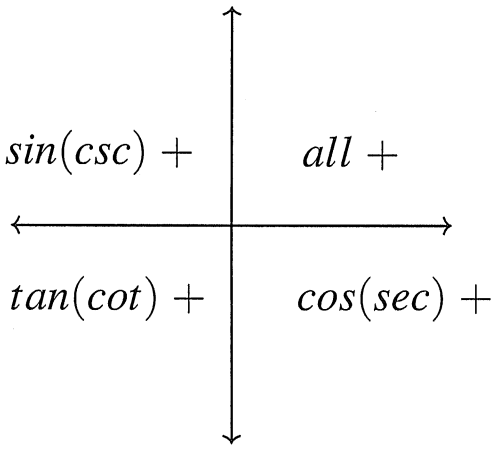
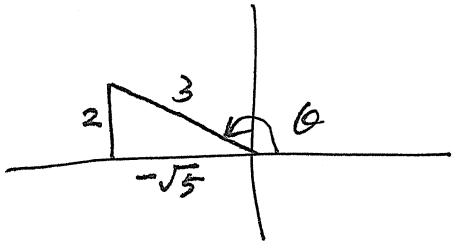
Trig Ratios of General Angles

- Given Ratio and Quadrant



$A\ S\ T\ C$

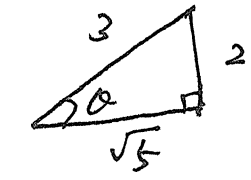
- $\sin\theta = \frac{2}{3}$, $\cos\theta < 0$ → find $\sec\theta$ → II



$\cos\theta = -\frac{\sqrt{5}}{3}$

$\sec\theta = -\frac{3}{\sqrt{5}}$

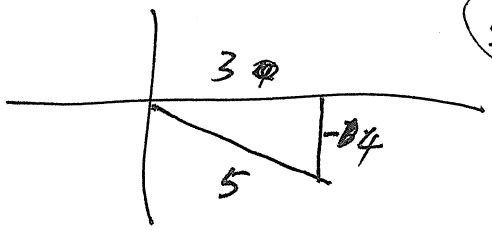
$= -\frac{3\sqrt{5}}{5}$



$\cos\theta = -\frac{\sqrt{5}}{3} \rightarrow \sec\theta = \frac{1}{\cos\theta}$

- $\cot\theta = -\frac{3}{4}$, $\cos\theta > 0$ → find $\sin\theta$ → IV

$\tan\theta = -\frac{4}{3}$



$\sin\theta = -\frac{4}{5}$

PCM 30S Name_____

Trigonometric Ratios of Any Angle

State the quadrant in which the terminal side of each angle lies.

1) 115°

2) 510°

3) 370°

4) –410°

5) –290°

6) 628°

7) –152°

8) 110°

Use the given point on the terminal side of angle θ to find the value of the trigonometric function indicated.

9) $\tan\theta; (-19, -9)$

10) $\sin\theta; (-\sqrt{17}, 8)$

11) $\tan\theta; (10, 5)$

12) $\tan \theta; (-9, \sqrt{19})$

13) $\tan \theta; (12, 7)$

14) $\cos \theta; (-15, 10)$

Find the value of the trig function indicated.

15) Find $\cos \theta$ if $\sin \theta = \frac{5}{13}$ and $\tan \theta < 0$

16) Find $\tan \theta$ if $\cos \theta = \frac{12}{13}$

17) Find $\cos \theta$ if $\tan \theta = \frac{\sqrt{5}}{2}$ and $\sin \theta > 0$

18) Find $\sin \theta$ if $\cos \theta = \frac{15}{17}$ and $0 < \theta < 180°$

19) Find $\cos \theta$ if $\tan \theta = \frac{15}{8}$

20) Find $\sin \theta$ if $\tan \theta = -\frac{3}{4}$ and $\cos \theta > 0$

21) Find $\tan \theta$ if $\sin \theta = \frac{3}{5}$ with $90° < \theta < 270°$

22) Find $\cos \theta$ if $\sin \theta = \frac{3}{5}$

Answers to Trigonometric Ratios of Any Angle (ID: 1)

1) II
2) II
3) I
4) IV
5) I
6) III
7) III
8) II
9) $\frac{9}{19}$
10) $\frac{8}{9}$
11) $\frac{1}{2}$
12) $-\frac{\sqrt{19}}{9}$
13) $\frac{7}{12}$
14) $-\frac{3\sqrt{13}}{13}$
15) $-\frac{12}{13}$
16) $\frac{5}{12}$ or $-\frac{5}{12}$
17) $\frac{2}{3}$
18) $\frac{8}{17}$
19) $\frac{8}{17}$ or $-\frac{8}{17}$
20) $-\frac{3}{5}$
21) $-\frac{3}{4}$
22) $\frac{4}{5}$ or $-\frac{4}{5}$

Name: Period: Date:

Practice Worksheet: Trig Ratios of Any Angle and Radius Length

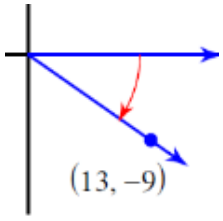
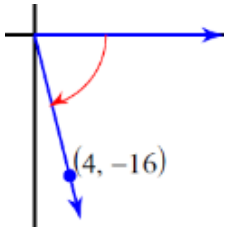
Evaluate the function given a point on the terminal side of the angle. Simplify completely and rationalize when needed.

1. Find $\csc\theta$, when the terminal side of θ passes through $(4,3)$.	2. Find $\sec\theta$, when the terminal side of θ passes through $(-8,15)$.	3. Find $\tan\theta$, when the terminal side of θ passes through $(-12,-5)$.
4. All of the sets of side lengths in #1-3 are examples of _____ _____.		
5. Find $\sin\theta$, when the terminal side of θ passes through $(1,-1)$.	6. Find $\cos\theta$, when the terminal side of θ passes through $\left(-\sqrt{3},-1\right)$.	7. Find $\cot\theta$, when the terminal side of θ passes through $(4,-4)$.
8. All of the angles in #5-7 are _____ angles on the ____ _____, but on a circle with a different _____.		

State the quadrant in which θ lies.

9. $\csc\theta > 0$ and $\cos\theta > 0$	10. $\tan\theta > 0$ and $\cos\theta < 0$	11. $\sin\theta > 0$ and $\cos\theta < 0$	12. $\sec\theta > 0$ and $\cot\theta > 0$

Find the exact value of the function given the graph. Simplify completely and rationalize when needed.

13. $\tan\theta =$ 	14. $\cot\theta =$ 

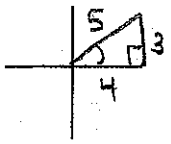
3, 4, 5 7, 40, 41
6, 8, 10 8, 15, 17
5, 12, 13

Name: Period: Date:

Practice Worksheet: Trig Ratios of Any Angle and Radius Length

Evaluate the function given a point on the terminal side of the angle. Simplify completely and rationalize when needed.

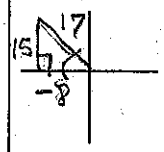
1. Find $\csc\theta$, when the terminal side of θ passes through $(4,3)$.



$\csc\theta = \frac{1}{\sin\theta}$

$\frac{hyp}{opp} = \frac{5}{3}$

2. Find $\sec\theta$, when the terminal side of θ passes through $(-8,15)$.



$8^2 + 15^2 = c^2$

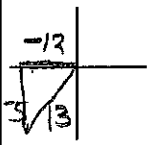
$64 + 225 = c^2$

$289 = c^2$

$17 = c$

$\sec\theta = \frac{1}{\cos\theta} = \frac{17}{8}$

3. Find $\tan\theta$, when the terminal side of θ passes through $(-12,-5)$.



$(12)^2 + 5^2 = c^2$

$144 + 25 = c^2$

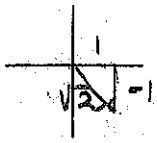
$169 = c^2$

$13 = c$

$\tan\theta = \frac{-5}{-12} = \frac{5}{12}$

4. All of the sets of side lengths in #1-3 are examples of Pythagorean Triples.

5. Find $\sin\theta$, when the terminal side of θ passes through $(1,-1)$.



$1^2 + 1^2 = c^2$

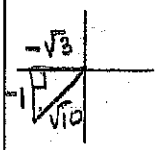
$1 + 1 = c^2$

$2 = c^2$

$c = \sqrt{2}$

$\sin\theta = \frac{-1}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{-\sqrt{2}}{2}$

6. Find $\cos\theta$, when the terminal side of θ passes through $(-\sqrt{3},-1)$.



$(\sqrt{3})^2 + 1^2 = c^2$

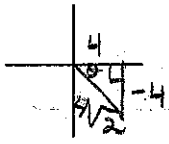
$9 + 1 = c^2$

$10 = c^2$

$c = \sqrt{10}$

$\cos\theta = \frac{-\sqrt{3}}{10}$

7. Find $\cot\theta$, when the terminal side of θ passes through $(4,-4)$.



$\cot\theta = \frac{1}{\tan\theta} = \frac{adj}{opp}$

$\cot\theta = \frac{4}{-4} = -1$

$4^2 + 4^2 = c^2$

$16 + 16 = c^2$

$32 = c^2$

$c = \sqrt{32}$

$c = 4\sqrt{2}$

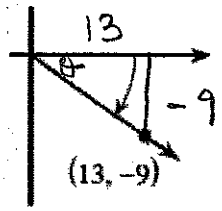
8. All of the angles in #5-7 are acute angles on the unit circle but on a circle with a different radius.

State the quadrant in which θ lies.

9. $\csc\theta > 0$ and $\cos\theta > 0$	10. $\tan\theta > 0$ and $\cos\theta < 0$	11. $\sin\theta > 0$ and $\cos\theta < 0$	12. $\sec\theta > 0$ and $\cot\theta > 0$
same as sin Q1	Q3	Q2	same as cosθ same as tanθ Q1

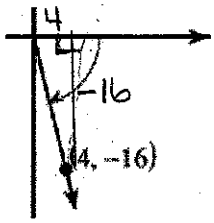
Find the exact value of the function given the graph. Simplify completely and rationalize when needed.

13. $\tan\theta =$



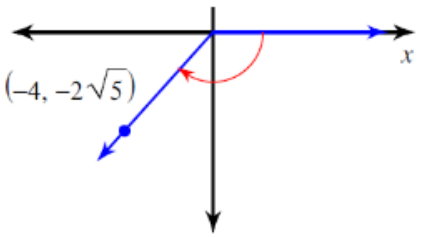
$\tan\theta = \frac{-9}{13}$

14. $\cot\theta =$

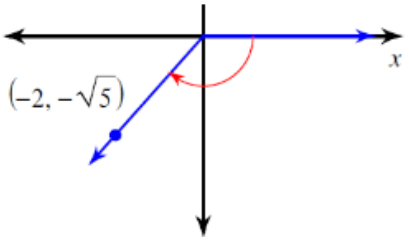


$\cot\theta = \frac{1}{\tan\theta} = \frac{adj}{opp} = \frac{4}{-16} = \frac{-1}{4}$

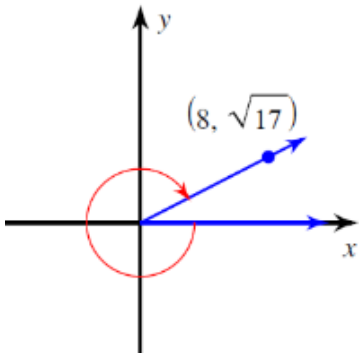
15. $\sin\theta =$



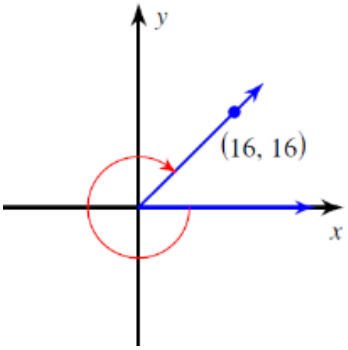
16. $\csc\theta =$



17. $\cos\theta =$



18. $\sec\theta =$



Find the indicated trig ratio in the specified quadrant. Simplify completely and rationalize when needed.

19. $\sin\theta = -\frac{3}{5}$ and θ is in Q4.
Find $\cos\theta$.

20. $\cos\theta = \frac{7}{25}$ and θ is in Q1.
Find $\csc\theta$.

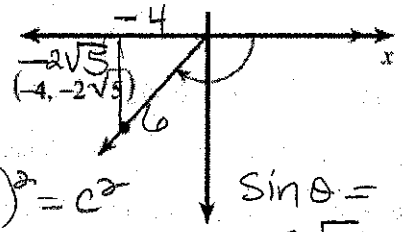
21. $\sec\theta = -\frac{9}{4}$ and θ is in Q3.
Find $\tan\theta$.

22. $\csc\theta = -2$ and θ is in Q4.
Find $\cot\theta$.

23. $\tan\theta = \frac{3}{2}$ and θ is in Q3.
Find $\sec\theta$.

24. $\cot\theta = -3$ and θ is in Q2.
Find $\sin\theta$.

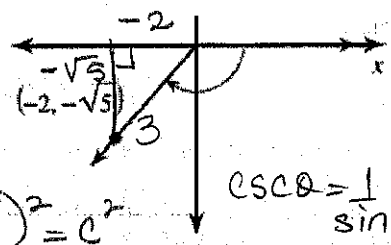
15. $\sin\theta =$



$4^2+(2\sqrt{5})^2=c^2$
$16+4(5)=c^2$
$16+20=c^2$
$36=c^2 \rightarrow c=6$

$\sin\theta = \frac{-2\sqrt{5}}{6} = \frac{-\sqrt{5}}{3}$

16. $\csc\theta =$

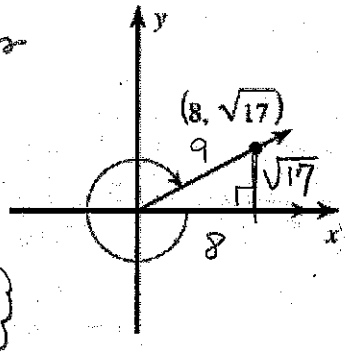


$2^2+(\sqrt{5})^2=c^2$
$4+5=c^2$
$9=c^2$
$c=3$

$\csc\theta = \frac{1}{\sin\theta} = \frac{hyp}{opp} = \frac{3}{-\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{-3\sqrt{5}}{5}$

17. $\cos\theta =$

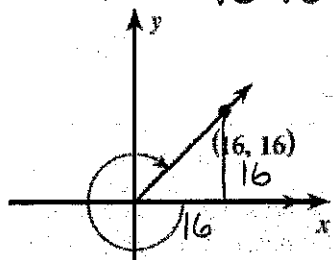
$8^2+(\sqrt{17})^2=c^2$
$64+17=c^2$
$81=c^2$
$c=9$



$\cos\theta = \frac{8}{9}$

18. $\sec\theta =$

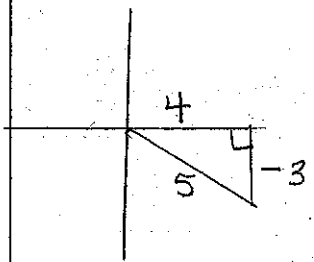
$16^2+16^2=c^2$
$256+256=c^2$
$512=c^2$
$c=\sqrt{512}$
$c=\sqrt{256 \cdot 2}$
$c=16\sqrt{2}$



$\sec\theta = \frac{1}{\cos\theta} = \frac{hyp}{adj}$
$\sec\theta = \frac{16\sqrt{2}}{16} = \sqrt{2}$

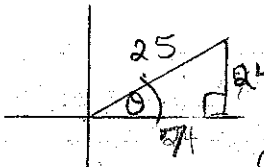
Find the indicated trig ratio in the specified quadrant. Simplify completely and rationalize when needed.

19. $\sin\theta = -\frac{3}{5}$ and θ is in Q4.
Find $\cos\theta$.



$\cos\theta = \frac{4}{5}$

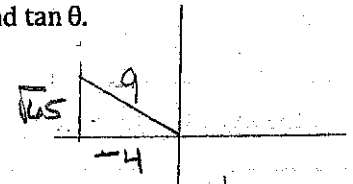
20. $\cos\theta = \frac{7}{25}$ and θ is in Q1.
Find $\csc\theta$.



$7^2+b^2=25^2$
$49+b^2=625$
$b^2=576$
$b=24$

$\csc\theta = \frac{1}{\sin\theta} = \frac{hyp}{opp} = \frac{25}{24}$

21. $\sec\theta = -\frac{9}{4}$ and θ is in Q3.
Find $\tan\theta$.

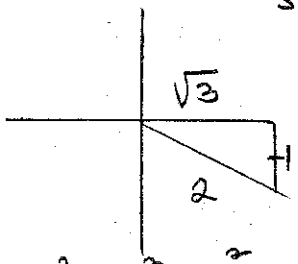


$4^2+b^2=9^2$
$16+b^2=81$
$b^2=65$
$b=\sqrt{65}$

$\tan\theta = -\frac{\sqrt{65}}{4}$

22. $\csc\theta = -2$ and θ is in Q4.
Find $\cot\theta$.

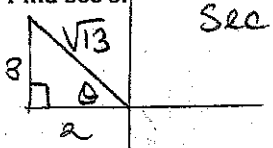
$\sin\theta = \frac{-1}{2}$



$1^2+b^2=2^2$
$1+b^2=4$
$b^2=3$
$b=\sqrt{3}$

$\cot\theta = \frac{1}{\tan\theta} = \frac{adj}{opp} = -\sqrt{3}$

23. $\tan\theta = \frac{3}{2}$ and θ is in Q3.
Find $\sec\theta$.

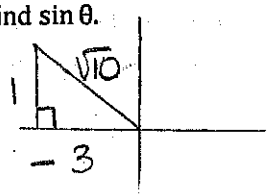


$3^2+2^2=c^2$
$9+4=c^2$
$13=c^2$
$c=\sqrt{13}$

$\sec\theta = \frac{1}{\cos\theta} = \frac{hyp}{adj} = \frac{\sqrt{13}}{2}$

24. $\cot\theta = -3$ and θ is in Q2.
Find $\sin\theta$.

$\tan\theta = \frac{-1}{3} = \frac{opp}{adj}$



$1^2+3^2=c^2$
$1+9=c^2$
$10=c^2$
$c=\sqrt{10}$

$\sin\theta = \frac{1}{\sqrt{10}} \cdot \frac{\sqrt{10}}{\sqrt{10}} = \frac{\sqrt{10}}{10}$

Use the given point on the terminal side of angle θ to find the value of the trigonometric function indicated.

13) csc θ; $(2, -4)$

14) cos θ; $(2\sqrt{5}, -4)$

15) csc θ; $(8, \sqrt{17})$

16) sin θ; $(7, -\sqrt{15})$

Find the value of the trig function indicated.

17) Find sin θ if cot $\theta = \frac{4}{3}$

18) Find cot θ if sin $\theta = \frac{\sqrt{3}}{2}$

19) Find sec θ if sin $\theta = \frac{2\sqrt{5}}{5}$

20) Find tan θ if csc $\theta = \sqrt{2}$

Answers to Trigonometric Ratios of Any Angle Worksheet

13) $-\frac{\sqrt{5}}{2}$

14) $\frac{\sqrt{5}}{3}$

15) $\frac{9\sqrt{17}}{17}$

16) $-\frac{\sqrt{15}}{8}$

17) $\frac{3}{5}$

18) $\frac{\sqrt{3}}{3}$

19) $\sqrt{5}$

20) 1

PreCalculus
Trig Ratios of any angle WS #1

Find the values of the six trig. functions for angle θ in standard position if a point with the given coordinates lies on its terminal side.

1. (1, -5)

2. (-3, -4)

3. (-5,6)

Suppose θ is an angle in standard position whose terminal side lies in the given quadrant. Use the given trig. function value to find the values of the remaining five trig. functions.

3. Quadrant IV; $\cot\theta = -\frac{3}{4}$

4. Quadrant I;$\csc\theta = \frac{\sqrt{13}}{2}$

5. Quadrant II; $\cos\theta = \frac{-\sqrt{2}}{20}$

6. Quadrant III; $\sin\theta = \frac{-4}{9}$

Determine which Quadrant θ is in.

7. $\sin\theta < 0$ and $\sec < 0$

8. $\tan\theta > 0$ and $\cos\theta < 0$

9. $\cos\theta > 0$ and $\sin\theta < 0$

PreCalculus
Trig Ratios of any angle WS #1

Find the values of the six trig. functions for angle θ in standard position if a point with the given coordinates lies on its terminal side.

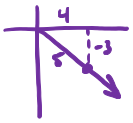
1. (1, -5) $r=\sqrt{1^2+(-5)^2}=\sqrt{26}$
$x=1\ \ y=-5$
$\sin\theta=\frac{-5}{\sqrt{26}}=\frac{-5\sqrt{26}}{26}\quad \csc\theta=-\frac{\sqrt{26}}{5}$
$\cos\theta=\frac{1}{\sqrt{26}}=\frac{\sqrt{26}}{26}\quad \sec\theta=\sqrt{26}$
$\tan\theta=-5\quad \cot\theta=-\frac{1}{5}$

2. (-3, -4) $r=\sqrt{(-3)^2+(-4)^2}=5$
$x=-3\ \ y=-4$
$\sin\theta=-\frac{4}{5}\quad \csc\theta=-\frac{5}{4}$
$\cos\theta=-\frac{3}{5}\quad \sec\theta=-\frac{5}{3}$
$\tan\theta=\frac{4}{3}\quad \cot\theta=\frac{3}{4}$

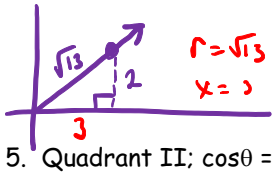
3. (-5,6) $r=\sqrt{(-5)^2+6^2}=\sqrt{61}$
$x=-5\ \ y=6$
$\sin\theta=\frac{6}{\sqrt{61}}=\frac{6\sqrt{61}}{61}\quad \csc\theta=\frac{\sqrt{61}}{6}$
$\cos\theta=-\frac{5}{\sqrt{61}}=-\frac{5\sqrt{61}}{61}\quad \sec\theta=-\frac{\sqrt{61}}{5}$
$\tan\theta=-\frac{6}{5}\quad \cot\theta=-\frac{5}{6}$

Suppose θ is an angle in standard position whose terminal side lies in the given quadrant. Use the given trig. function value to find the values of the remaining five trig. functions.

3. Quadrant IV; $\cot\theta=-\frac{3}{4}=\frac{x}{y}$
$\sin\theta=-\frac{3}{5}\quad \csc\theta=-\frac{5}{3}$
$\cos\theta=\frac{4}{5}\quad \sec\theta=\frac{5}{4}$
$\tan\theta=-\frac{4}{3}$

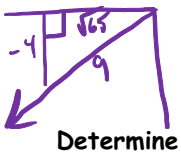


4. Quadrant I; $\csc\theta=\frac{\sqrt{13}}{2}=\frac{r}{y}$
$r=\sqrt{13}\quad x=3\quad y=2$
$\sin\theta=\frac{2\sqrt{13}}{13}\quad \tan\theta=\frac{2}{3}$
$\cos\theta=\frac{3\sqrt{13}}{13}\quad \sec\theta=\frac{\sqrt{13}}{3}\quad \cot\theta=\frac{3}{2}$



5. Quadrant II; $\cos\theta=\frac{-\sqrt{2}}{20}=\frac{x}{r}$
$\sin\theta=\frac{\sqrt{398}}{20}\quad \cos\theta=-\frac{\sqrt{2}}{20}\quad \tan\theta=-\sqrt{199}$
$\csc\theta=\frac{10\sqrt{398}}{199}\quad \sec\theta=-10\sqrt{2}\quad \cot\theta=-\frac{\sqrt{199}}{199}$

6. Quadrant III; $\sin\theta=\frac{-4}{9}$
$\sin\theta=-\frac{4}{9}\quad \cos\theta=\frac{\sqrt{65}}{9}\quad \tan\theta=-\frac{4\sqrt{65}}{65}$
$\csc\theta=-\frac{9}{4}\quad \sec\theta=\frac{9\sqrt{65}}{65}\quad \cot\theta=-\frac{\sqrt{65}}{4}$



Determine which Quadrant θ is in.

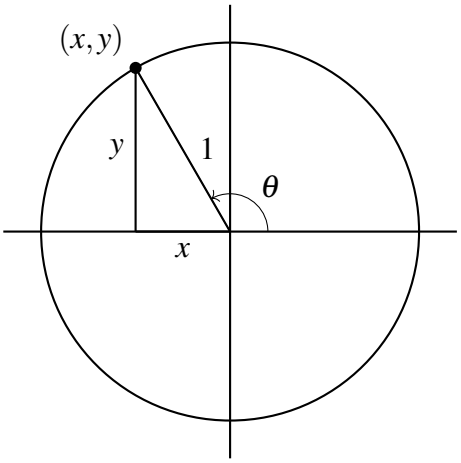
7. sin θ < 0 and sec < 0
III

8. tan θ>0 and cos θ<0
III

9. cos θ>0 and sin θ<0
IV

YouTube

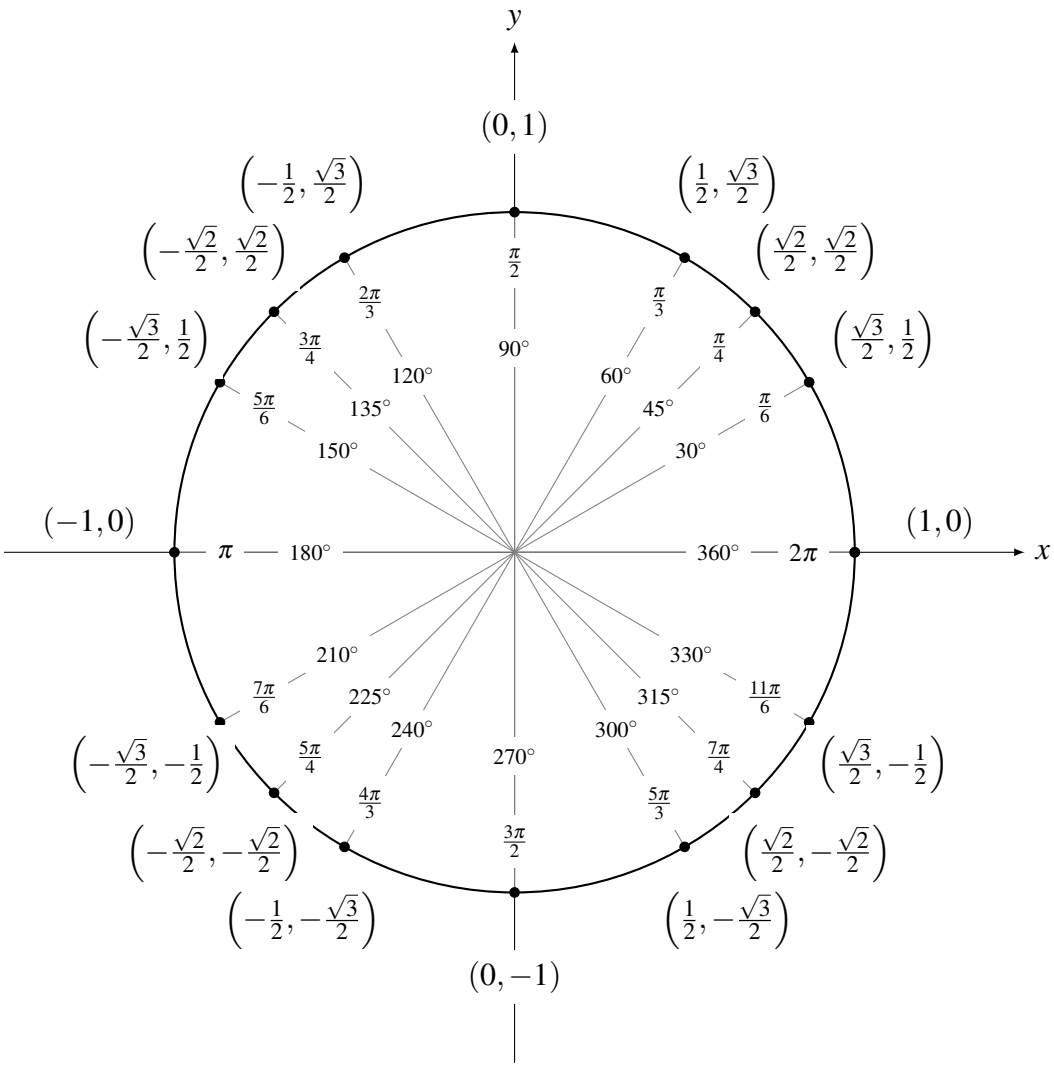
Unit Circle



$$\sin\theta = \frac{y}{1} = y \qquad \csc\theta = \frac{1}{y}$$

$$\cos\theta = \frac{x}{1} = x \qquad \sec\theta = \frac{1}{x}$$

$$\tan\theta = \frac{y}{x} \qquad \cot\theta = \frac{x}{y}$$



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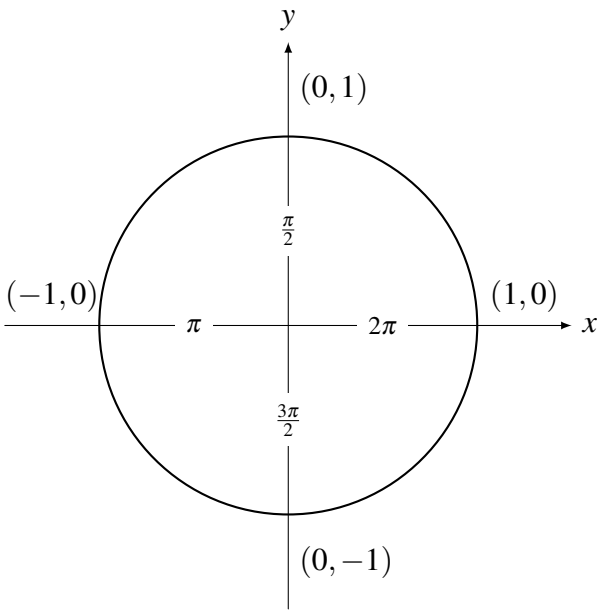
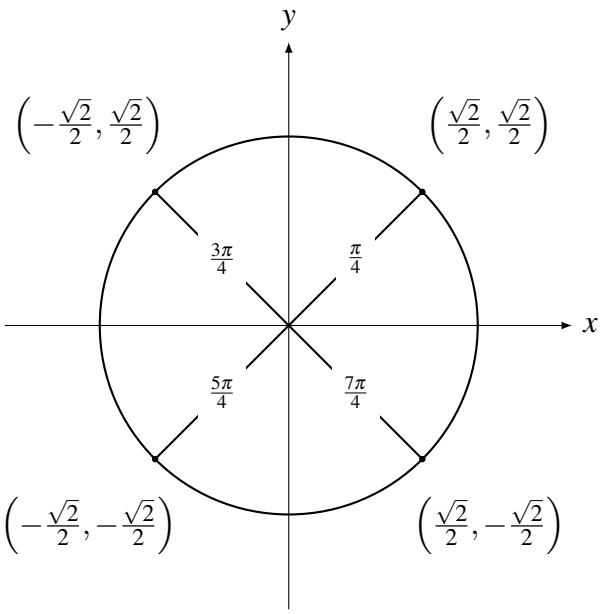
Angle Charts

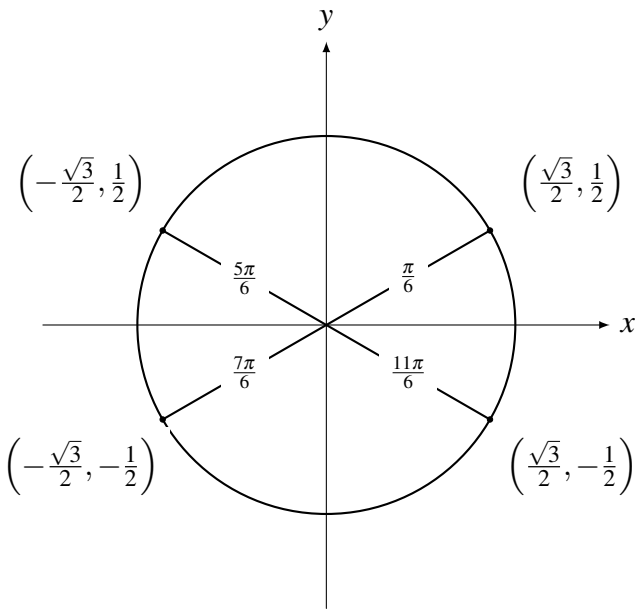
- $90° \,/\, 180° \,/\, 270° \,/\, 360°$



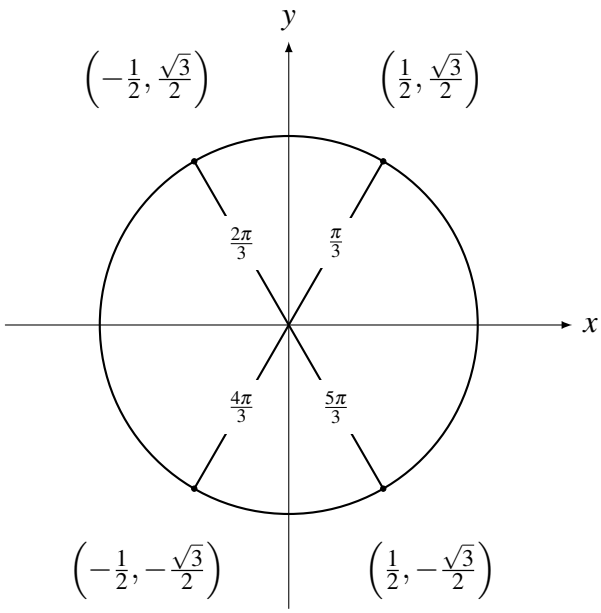
- $45° \,/\, 135° \,/\, 225° \,/\, 315°$



- $30° \,/\, 150° \,/\, 210° \,/\, 330°$



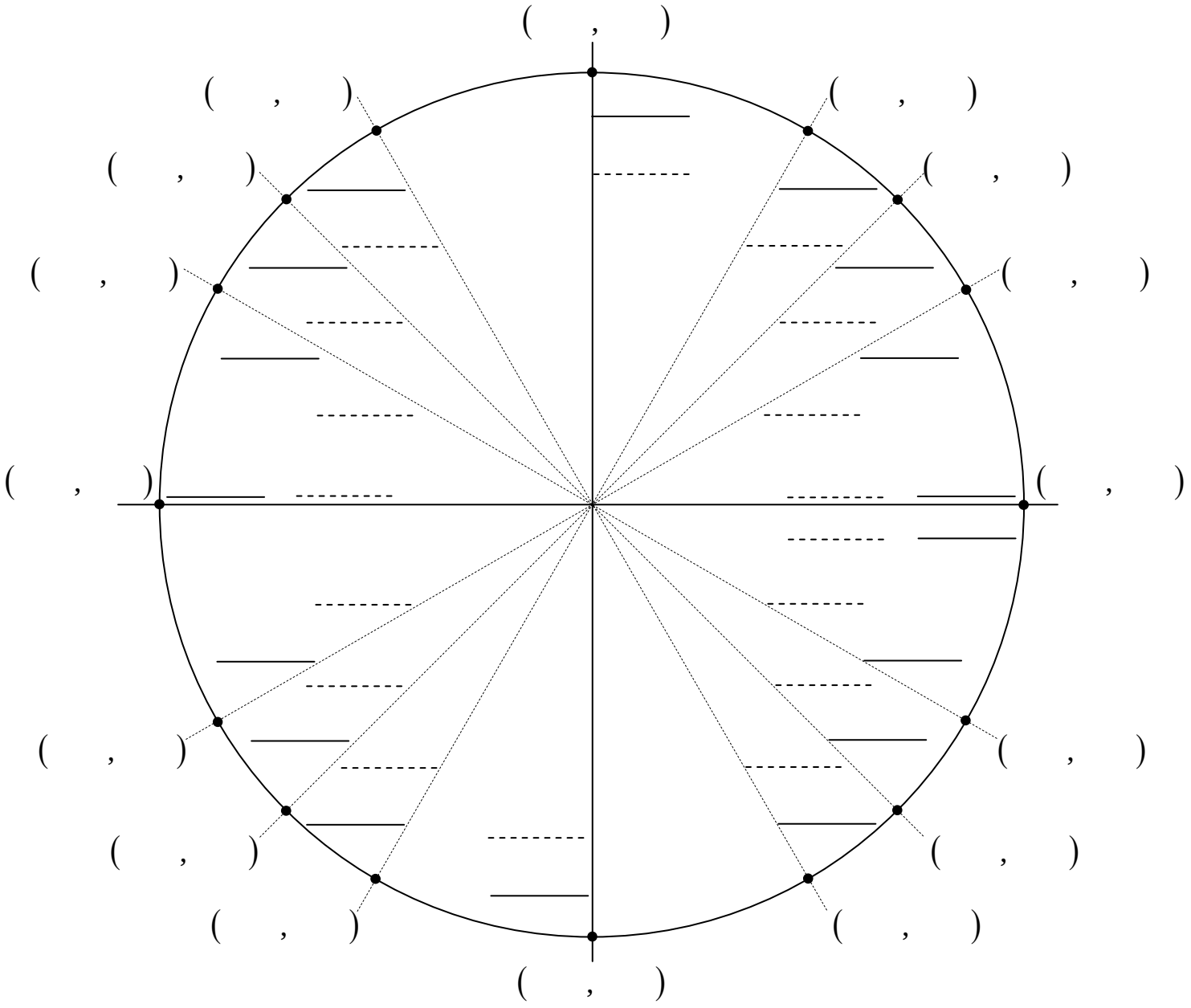
- $60° \,/\, 120° \,/\, 240° \,/\, 300°$



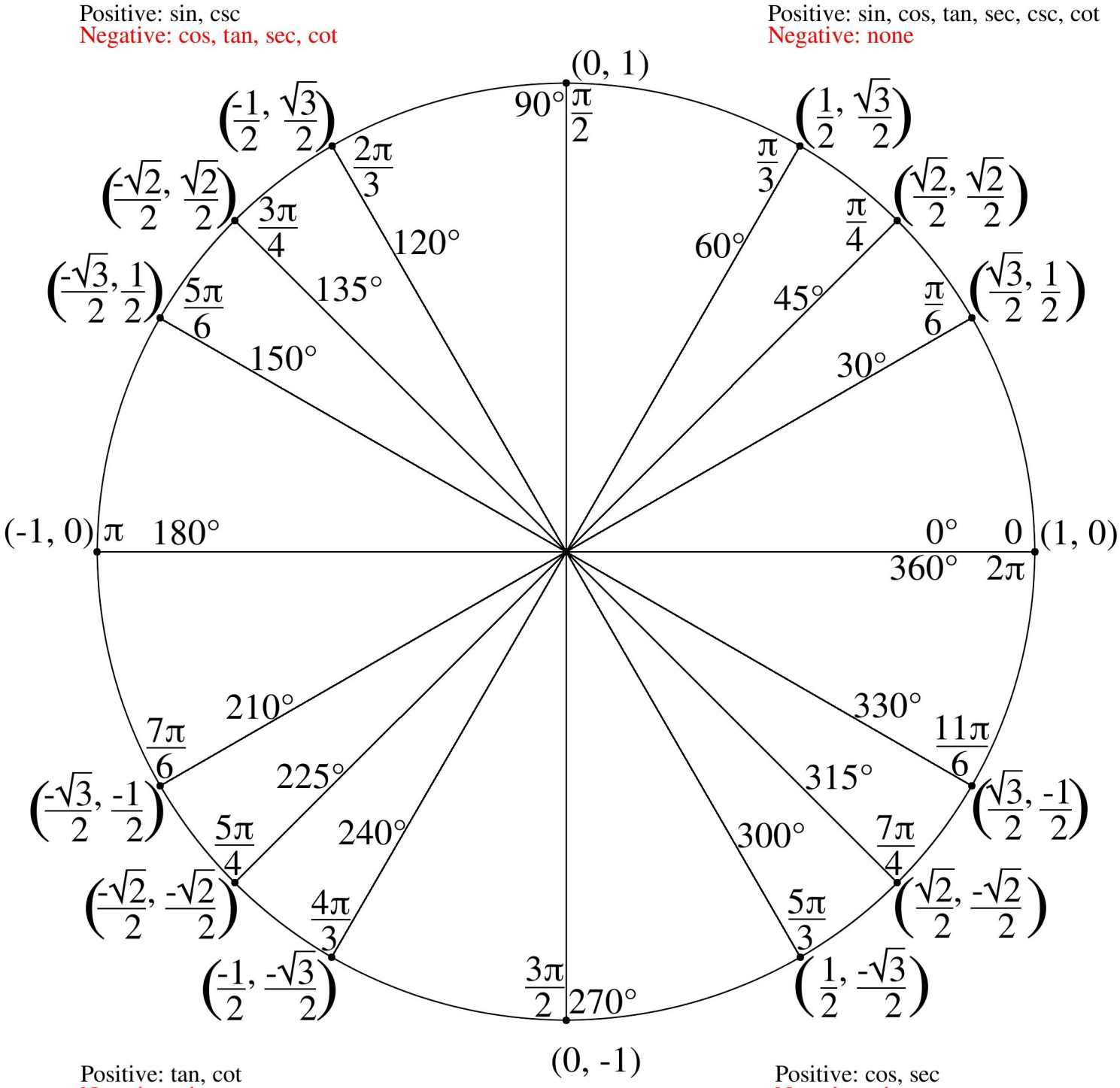
The Unit Circle

Practice filling in this unit circle until you can complete it in 5 minutes.

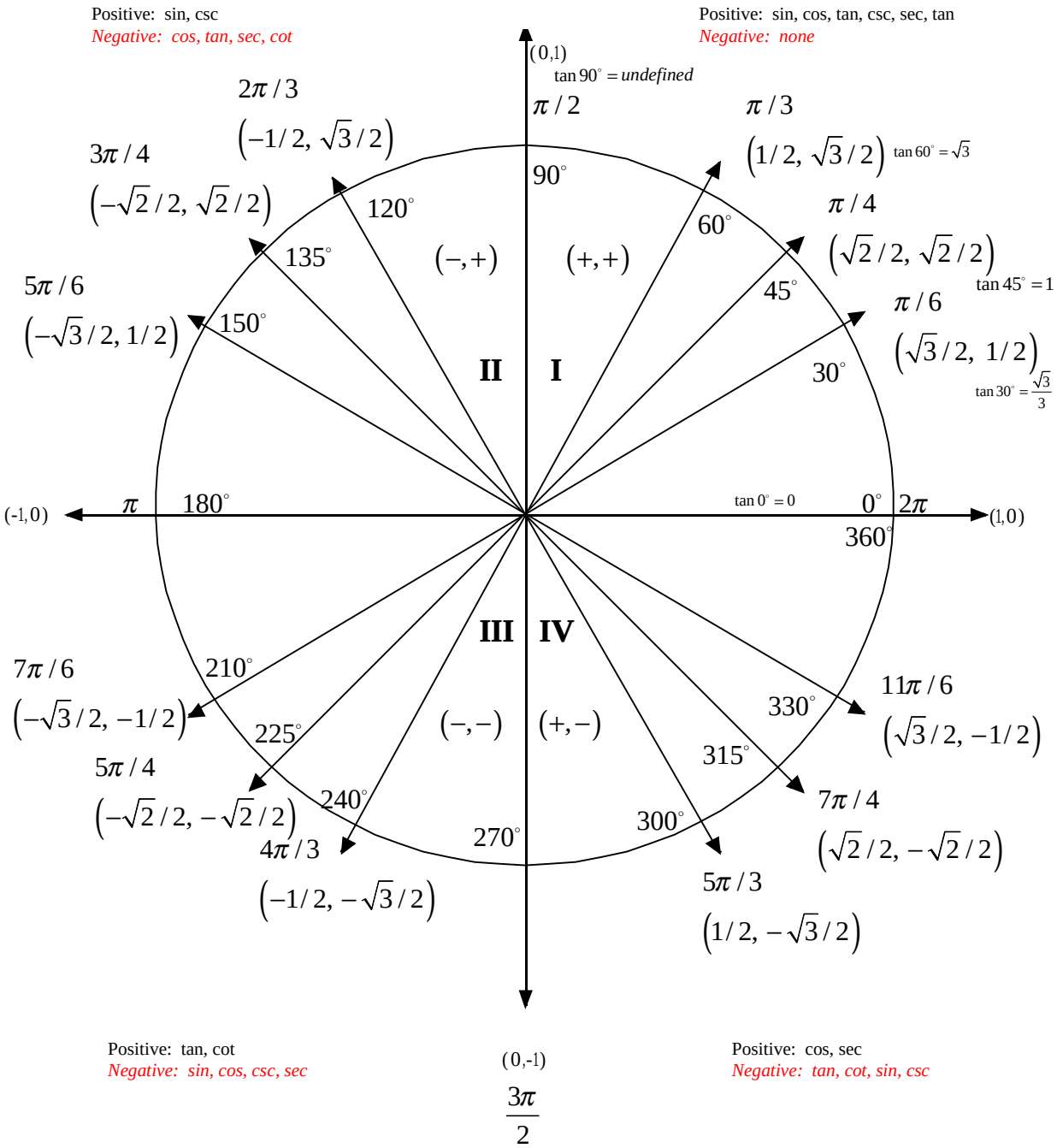
Place the **degree** angle measure of each angle in the **dashed** blanks inside the circle, and the **radian** measure of each angle in the **solid** blanks inside the circle. Place the coordinates of each point in the ordered pairs outside the circle.



The Unit Circle



Angles and Radians of a Unit Circle



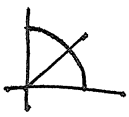
YouTube

Unit Circle Worksheet

- $\sin(45°)$
- $\cos(240°)$
- $\tan(150°)$
- $\sec(120°)$
- $\csc(330°)$
- $\sin(660°)$
- $\csc(-45°)$
- $\sec(-570°)$
- $\cot(-150°)$
- $\tan(\frac{\pi}{3})$
- $\cos(\frac{11\pi}{6})$
- $\sec(\frac{3\pi}{4})$
- $\cos(\frac{3\pi}{2})$
- $\tan(\pi)$
- $\sec(-\frac{11\pi}{6})$
- $\csc(-\frac{17\pi}{3})$
- $\sin(\frac{19\pi}{6})$
- $\cot(-\frac{5\pi}{4})$

Unit Circle Worksheet

- sin (45°)

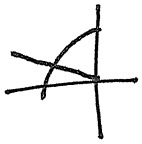


$\frac{\sqrt{2}}{2}$

- cos (240°)

$-\frac{1}{2}$

- tan (150°)



$-\frac{1}{\sqrt{3}} = -\frac{\sqrt{3}}{3}$

- sec (120°)

$\cos(120°) = -\frac{1}{2}$

-2

- csc (330°)

$\sin(330°) = -\frac{1}{2}$

-2

- sin (660°) $= \sin(300°)$

$-\frac{\sqrt{3}}{2}$

- csc (-45°) $= \csc(315°)$

$\sin(315°) = -\frac{\sqrt{2}}{2}$

$-\sqrt{2}$

- sec (-570°) $= \sec(150°)$

$\cos(150°) = -\frac{\sqrt{3}}{2}$

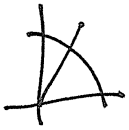
$-\frac{2}{\sqrt{3}} = -\frac{2\sqrt{3}}{3}$

- cot (-150°) $= \cot(210°)$

$\tan(210°) = \frac{1}{\sqrt{3}}$

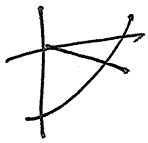
$\sqrt{3}$

- tan $(\frac{\pi}{3})$ $\tan 60°$



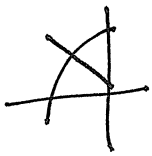
$\sqrt{3}$

- cos $(\frac{11\pi}{6})$ $\cos(330°)$



$\frac{\sqrt{3}}{2}$

- sec $(\frac{3\pi}{4})$ $\sec(135°)$



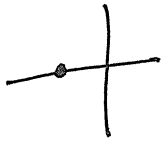
$\cos(135°) = -\frac{1}{\sqrt{2}}$

$-\sqrt{2}$

- cos $(\frac{3\pi}{2})$ $= \cos(270°)$

0

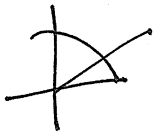
- tan (π) $\tan(180°)$



0

- sec $(-\frac{11\pi}{6})$ $\sec(-330°)$

$= \sec(30°)$



$\cos(30°) = \frac{\sqrt{3}}{2}$

$\frac{2}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$

- csc $(-\frac{17\pi}{3})$ $= \csc\frac{\pi}{3}$

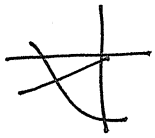
$\csc 60°$

$\sin 60° = \frac{\sqrt{3}}{2}$

$\frac{2}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$

- sin $(\frac{19\pi}{6})$ $\sin(\frac{\pi}{6})$

$\sin(210°)$



$-\frac{1}{2}$

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

$\cot(135°)$

$\tan(135°) = -1$

Student Name: _____ **Score:**

Trigonometric ratios for a given angle

Find the value of a given trigonometric ratio:

$\sin 30^0$ =

$\csc 60^0$ =

$\cos 45^0$ =

$\tan 60^0$ =

$\cot 60^0$ =

$\sec 30^0$ =

$\sec 45^0$ =

$\cot 45^0$ =

$\csc 0^0$ =

$\sin 0^0$ =

$\tan 30^0$ =

$\tan 90^0$ =

$\cot 90^0$ =

$\cos 90^0$ =

$\cos 0^0$ =

$\csc 30^0$ =

Student Name: _____ **Score:**

Answers:

Find the value of a given trigonometric ratio:

$\sin 30^0 = \frac{1}{2}$

$\csc 60^0 = \frac{2}{\sqrt{3}}$ *or* $\frac{2\sqrt{3}}{3}$

$\cos 45^0 = \frac{1}{\sqrt{2}}$ *or* $\frac{\sqrt{2}}{2}$

$\tan 60^0 = \sqrt{3}$

$\cot 60^0 = \frac{1}{\sqrt{3}}$ *or* $\frac{\sqrt{3}}{3}$

$\sec 30^0 = \frac{2}{\sqrt{3}}$ *or* $\frac{2\sqrt{3}}{3}$

$\sec 45^0 = \sqrt{2}$

$\cot 45^0 = 1$

$\csc 0^0$ = infinity

$\sin 0^0 = 0$

$\tan 30^0 = \frac{1}{\sqrt{3}}$ *or* $\frac{\sqrt{3}}{3}$

$\tan 90^0$ = infinity

$\cot 90^0 = 0$

$\cos 90^0 = 0$

$\cos 0^0 = 1$

$\csc 30^0 = 2$

Student Name: _____ **Score:**

Find the exact value of a given trigonometric ratio

$\sin\frac{\pi}{2} =$	$\cos\frac{\pi}{2} =$	$\tan\frac{\pi}{6} =$
$\sin\frac{\pi}{3} =$	$\cot 0 =$	$\sec\frac{\pi}{4} =$
$\csc\frac{\pi}{6} =$	$\tan\frac{\pi}{2} =$	$\cos\frac{\pi}{4} =$
$\cos\frac{\pi}{3} =$	$\csc\frac{\pi}{4} =$	$\tan\frac{\pi}{4} =$
$\tan 0 =$	$\cos\frac{\pi}{6} =$	$\sec\frac{\pi}{2} =$
$\cot\frac{\pi}{2} =$	$\csc\frac{\pi}{3} =$	$\sin\frac{\pi}{6} =$
$\sec\frac{\pi}{6} =$	$\tan\frac{\pi}{3} =$	$\csc\frac{\pi}{2} =$
$\cot\frac{\pi}{4} =$	$\sec\frac{\pi}{3} =$	$\cot\frac{\pi}{6} =$

Student Name: _____ **Score:**

Answers:

$\sin\frac{\pi}{2} = 1$ $\cos\frac{\pi}{2} = 0$ $\tan\frac{\pi}{6} = \frac{1}{\sqrt{3}}$ *or* $\frac{\sqrt{3}}{3}$

$\sin\frac{\pi}{3} = \frac{\sqrt{3}}{2}$ $\cot 0 = \infty$ $\sec\frac{\pi}{4} = \sqrt{2}$

$\csc\frac{\pi}{6} = 2$ $\tan\frac{\pi}{2} = \infty$ $\cos\frac{\pi}{4} = \frac{1}{\sqrt{2}}$ *or* $\frac{\sqrt{2}}{2}$

$\cos\frac{\pi}{3} = \frac{1}{2}$ $\csc\frac{\pi}{4} = \sqrt{2}$ $\tan\frac{\pi}{4} = 1$

$\tan 0 = 0$ $\cos\frac{\pi}{6} = \frac{\sqrt{3}}{2}$ $\sec\frac{\pi}{2} = \infty$

$\cot\frac{\pi}{2} = 0$ $\csc\frac{\pi}{3} = \frac{2}{\sqrt{3}}$ *or* $\frac{2\sqrt{3}}{3}$ $\sin\frac{\pi}{6} = \frac{1}{2}$

$\sec\frac{\pi}{6} = \frac{2}{\sqrt{3}}$ *or* $\frac{2\sqrt{3}}{3}$ $\tan\frac{\pi}{3} = \sqrt{3}$ $\csc\frac{\pi}{2} = 1$

$\cot\frac{\pi}{4} = 1$ $\sec\frac{\pi}{3} = 2$ $\cot\frac{\pi}{6} = \sqrt{3}$

PreCalculus Name_____

Sin and Cos on the Unit Circle

Date_____ Period____

Find the exact value of each trigonometric function.

1) $\sin 0°$

2) $\sin \frac{\pi}{2}$

3) $\sin 225°$

4) $\cos 0$

5) $\sin \frac{5\pi}{6}$

6) $\sin 330°$

7) $\cos 330°$

8) $\sin 180°$

9) $\cos \frac{\pi}{3}$

10) $\cos \frac{3\pi}{4}$

11) $\cos 225°$

12) $\sin \frac{4\pi}{3}$

PreCalculus Name_____

Sin and Cos on the Unit Circle

Date_____ Period____

Find the exact value of each trigonometric function.

1) $\sin 0°$

0

2) $\sin \frac{\pi}{2}$

1

3) $\sin 225°$

$-\frac{\sqrt{2}}{2}$

4) $\cos 0$

1

5) $\sin \frac{5\pi}{6}$

$\frac{1}{2}$

6) $\sin 330°$

$-\frac{1}{2}$

7) $\cos 330°$

$\frac{\sqrt{3}}{2}$

8) $\sin 180°$

0

9) $\cos \frac{\pi}{3}$

$\frac{1}{2}$

10) $\cos \frac{3\pi}{4}$

$-\frac{\sqrt{2}}{2}$

11) $\cos 225°$

$-\frac{\sqrt{2}}{2}$

12) $\sin \frac{4\pi}{3}$

$-\frac{\sqrt{3}}{2}$

PreCalculus Name_____

All Trig Ratios on the Unit Circle

Date_____ Period____

Find the exact value of each trigonometric function.

1) sec 225°

2) cos 60°

3) $\sec \frac{5\pi}{6}$

4) $\sin \frac{\pi}{2}$

5) cos 180°

6) csc 30°

7) cot 300°

8) csc π

9) cos 330°

10) csc 315°

11) cos 240°

12) csc 0°

13) sin 855°

14) tan –315°

15) $\cos \frac{11\pi}{3}$

16) tan –270°

17) $\cot \frac{\pi}{4}$

18) tan –480°

PreCalculus Name_____

All Trig Ratios on the Unit Circle

Date_____ Period____

Find the exact value of each trigonometric function.

1) sec 225°

$-\sqrt{2}$

2) cos 60°

$\frac{1}{2}$

3) sec $\frac{5\pi}{6}$

$-\frac{2\sqrt{3}}{3}$

4) sin $\frac{\pi}{2}$

1

5) cos 180°

−1

6) csc 30°

2

7) cot 300°

$-\frac{\sqrt{3}}{3}$

8) csc π

Undefined

9) cos 330°

$\frac{\sqrt{3}}{2}$

10) csc 315°

$-\sqrt{2}$

11) cos 240°

$-\frac{1}{2}$

12) csc 0°

Undefined

13) sin 855°

$\frac{\sqrt{2}}{2}$

14) tan −315°

1

15) cos $\frac{11\pi}{3}$

$\frac{1}{2}$

16) tan −270°

Undefined

17) cot $\frac{\pi}{4}$

1

18) tan −480°

$\sqrt{3}$

FST Name_____

Worksheet 5.4 - Day 1 - The Unit Circle

Date_____ Mods____

Find the exact value of each trigonometric function.

1) $\tan -\frac{9\pi}{4}$

2) $\cos -945°$

3) $\csc \frac{7\pi}{6}$

4) $\cos -840°$

5) $\cos \frac{7\pi}{4}$

6) $\sin 5\pi$

7) $\tan -\frac{2\pi}{3}$

8) $\cot \frac{11\pi}{3}$

9) $\sin -780°$

10) $\csc \frac{\pi}{2}$

11) $\sin \frac{13\pi}{4}$

12) $\tan -\frac{11\pi}{3}$

13) $\cot 60°$

14) $\cot -\frac{\pi}{4}$

15) $\cos -\frac{5\pi}{6}$

16) $\cot -\frac{13\pi}{6}$

17) $\sin -660°$

18) $\csc -\frac{7\pi}{6}$

19) $\sin -690°$

20) $\csc 600°$

21) $\csc 315°$

22) $\sec 570°$

23) $\sin \frac{21\pi}{4}$

24) $\csc 45°$

25) $\sin 0$

26) $\sec \frac{19\pi}{4}$

27) $\tan \frac{13\pi}{3}$

28) $\sec -945°$

29) $\sec 750°$

30) $\cot -\frac{9\pi}{2}$

31) $\sec -\frac{23\pi}{6}$

32) $\cot 0°$

33) $\cot 900°$

34) $\cos \frac{3\pi}{2}$

35) $\tan -\frac{11\pi}{2}$

36) $\cos -30°$

37) $\sec \frac{5\pi}{2}$

38) $\cot -\frac{10\pi}{3}$

39) $\cot 495°$

40) $\tan -870°$

Answers to Worksheet 5.4 - Day 1 - The Unit Circle

1) -1

2) $-\frac{\sqrt{2}}{2}$

3) -2

4) $-\frac{1}{2}$

5) $\frac{\sqrt{2}}{2}$

6) 0

7) $\sqrt{3}$

8) $-\frac{\sqrt{3}}{3}$

9) $-\frac{\sqrt{3}}{2}$

10) 1

11) $-\frac{\sqrt{2}}{2}$

12) $\sqrt{3}$

13) $\frac{\sqrt{3}}{3}$

14) -1

15) $-\frac{\sqrt{3}}{2}$

16) $-\sqrt{3}$

17) $\frac{\sqrt{3}}{2}$

18) 2

19) $\frac{1}{2}$

20) $-\frac{2\sqrt{3}}{3}$

21) $-\sqrt{2}$

22) $-\frac{2\sqrt{3}}{3}$

23) $-\frac{\sqrt{2}}{2}$

24) $\sqrt{2}$

25) 0

26) $-\sqrt{2}$

27) $\sqrt{3}$

28) $-\sqrt{2}$

29) $\frac{2\sqrt{3}}{3}$

30) 0

31) $\frac{2\sqrt{3}}{3}$

32) Undefined

33) Undefined

34) 0

35) Undefined

36) $\frac{\sqrt{3}}{2}$

37) Undefined

38) $-\frac{\sqrt{3}}{3}$

39) -1

40) $\frac{\sqrt{3}}{3}$

Name_____ Date_____ Period_____

Worksheet 5.3B—Using the Unit Circle Practice

Without having a Unit Circle in front of you, give the simplified, exact, rationalized answer (if it exists) for each of the following. If the ration does not exist, write "DNE."

Set I: See if you can do these in 6 minutes:

1. $\sin\frac{5\pi}{6}$ 2. $\cos\frac{7\pi}{6}$ 3. $\sin\frac{3\pi}{4}$ 4. $\cos\frac{11\pi}{6}$ 5. $\sin\frac{5\pi}{4}$

6. $\cos\frac{4\pi}{3}$ 7. $\cos\frac{5\pi}{4}$ 8. $\sin\frac{2\pi}{3}$ 9. $\cos\frac{5\pi}{6}$ 10. $\sin\frac{3\pi}{2}$

Set II: See if you can do THESE in 6 minutes:

1. $\sec\frac{2\pi}{3}$ 2. $\csc\frac{7\pi}{4}$ 3. $\tan\frac{\pi}{2}$ 4. $\cot\frac{5\pi}{6}$ 5. $\sec\frac{3\pi}{4}$

6. $\csc\frac{11\pi}{6}$ 7. $\cot\frac{4\pi}{3}$ 8. $\sec\frac{7\pi}{6}$ 9. $\cot\frac{5\pi}{3}$ 10. $\sec\pi$

Set III: See if you can do these in 5 minutes:

1. $\cot\frac{11\pi}{6}$ 2. $\tan\pi$ 3. $\tan\frac{4\pi}{3}$ 4. $\cot\frac{\pi}{2}$ 5. $\sec\frac{5\pi}{3}$

6. $\csc\frac{7\pi}{4}$ 7. $\cot\frac{2\pi}{3}$ 8. $\sec\frac{11\pi}{6}$ 9. $\csc 0$ 10. $\cot\frac{5\pi}{4}$

Set IV: See if you can do these in 4 minutes:

1. $\sin 2\pi$ 2. $\cos\frac{3\pi}{2}$ 3. $\tan\frac{\pi}{6}$ 4. $\cot\frac{7\pi}{4}$ 5. $\sec\frac{5\pi}{6}$

6. $\csc\frac{5\pi}{3}$ 7. $\cot\frac{4\pi}{3}$ 8. $\sec\pi$ 9. $\sin\frac{7\pi}{6}$ 10. $\cos\frac{2\pi}{3}$

Name KEY Date Period

Worksheet 5.3B—Using the Unit Circle Practice

Without having a Unit Circle in front of you, give the simplified, exact, rationalized answer (if it exists) for each of the following. If the ration does not exist, write "DNE."

Set I: See if you can do these in 6 minutes:

1. $\sin\frac{5\pi}{6} = \frac{1}{2}$ 2. $\cos\frac{7\pi}{6} = -\frac{\sqrt{3}}{2}$ 3. $\sin\frac{3\pi}{4} = \frac{\sqrt{2}}{2}$ 4. $\cos\frac{11\pi}{6} = \frac{\sqrt{3}}{2}$ 5. $\sin\frac{5\pi}{4} = -\frac{\sqrt{2}}{2}$

6. $\cos\frac{4\pi}{3} = -\frac{1}{2}$ 7. $\cos\frac{5\pi}{4} = -\frac{\sqrt{2}}{2}$ 8. $\sin\frac{2\pi}{3} = \frac{\sqrt{3}}{2}$ 9. $\cos\frac{5\pi}{6} = -\frac{\sqrt{3}}{2}$ 10. $\sin\frac{3\pi}{2} = -1$

Set II: See if you can do THESE in 6 minutes:

1. $\sec\frac{2\pi}{3} = -2$ 2. $\csc\frac{7\pi}{4} = -\sqrt{2}$ 3. $\tan\frac{\pi}{2} = \text{DNE}$ 4. $\cot\frac{5\pi}{6} = -\sqrt{3}$ 5. $\sec\frac{3\pi}{4} = -\sqrt{2}$

6. $\csc\frac{11\pi}{6} = -2$ 7. $\cot\frac{4\pi}{3} = \frac{\sqrt{3}}{3}$ 8. $\sec\frac{7\pi}{6} = -\frac{2\sqrt{3}}{3}$ 9. $\cot\frac{5\pi}{3} =$ - 10. $\sec\pi = -1$

Set III: See if you can do these in 5 minutes:

1. $\cot\frac{11\pi}{6} = -\sqrt{3}$ 2. $\tan\pi = 0$ 3. $\tan\frac{4\pi}{3} = \sqrt{3}$ 4. $\cot\frac{\pi}{2} = 0$ 5. $\sec\frac{5\pi}{3} = 2$

6. $\csc\frac{7\pi}{4} = -\sqrt{2}$ 7. $\cot\frac{2\pi}{3} = -\frac{\sqrt{3}}{3}$ 8. $\sec\frac{11\pi}{6} = \frac{2\sqrt{3}}{3}$ 9. $\csc 0 = \text{DNE}$ 10. $\cot\frac{5\pi}{4} = 1$

Set IV: See if you can do these in 4 minutes:

1. $\sin 2\pi = 0$ 2. $\cos\frac{3\pi}{2} = 0$ 3. $\tan\frac{\pi}{6} = \frac{\sqrt{3}}{3}$ 4. $\cot\frac{7\pi}{4} = -1$ 5. $\sec\frac{5\pi}{6} = -\frac{2\sqrt{3}}{3}$

6. $\csc\frac{5\pi}{3} = -\frac{2\sqrt{3}}{3}$ 7. $\cot\frac{4\pi}{3} = \frac{\sqrt{3}}{3}$ 8. $\sec\pi = -1$ 9. $\sin\frac{7\pi}{6} = -\frac{1}{2}$ 10. $\cos\frac{2\pi}{3} = -\frac{1}{2}$

Set V: You are now ready to complete these in 2 minutes:

1. $\sin\frac{2\pi}{3}$ 2. $\cos\frac{5\pi}{4}$ 3. $\tan\frac{7\pi}{6}$ 4. $\cot\frac{3\pi}{2}$ 5. $\sec\frac{4\pi}{3}$

6. $\csc\frac{7\pi}{4}$ 7. $\cot\frac{11\pi}{6}$ 8. $\sec\frac{\pi}{2}$ 9. $\sin\frac{5\pi}{3}$ 10. $\csc\frac{5\pi}{6}$

Set VI: The Ghost Pepper Challenge—you've got 1 minute:

1. $\sin\frac{7\pi}{4}$ 2. $\csc\frac{5\pi}{3}$ 3. $\cot\frac{\pi}{2}$ 4. $\cot\frac{4\pi}{3}$ 5. $\sec\frac{5\pi}{6}$

6. $\cos\frac{11\pi}{6}$ 7. $\cot\frac{5\pi}{4}$ 8. $\csc\frac{7\pi}{6}$ 9. $\tan\frac{3\pi}{2}$ 10. $\sec\frac{2\pi}{3}$

Congratulations. Take a drink of water. You are now ready for tomorrow's quiz.

Set V: You are now ready to complete these in 2 minutes:

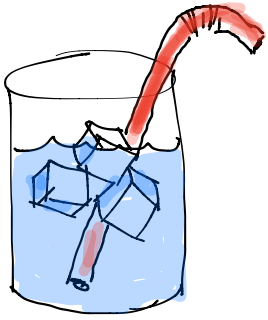
1. $\sin\frac{2\pi}{3} = \frac{\sqrt{3}}{2}$ 2. $\cos\frac{5\pi}{4} = -\frac{\sqrt{2}}{2}$ 3. $\tan\frac{7\pi}{6} = \frac{\sqrt{3}}{3}$ 4. $\cot\frac{3\pi}{2} = 0$ 5. $\sec\frac{4\pi}{3} = -2$

6. $\csc\frac{7\pi}{4} = -\sqrt{2}$ 7. $\cot\frac{11\pi}{6} = -\sqrt{3}$ 8. $\sec\frac{\pi}{2} = \text{DNE}$ 9. $\sin\frac{5\pi}{3} = -\frac{\sqrt{3}}{2}$ 10. $\csc\frac{5\pi}{6} = 2$

Set VI: The Ghost Pepper Challenge—you've got 1 minute:

1. $\sin\frac{7\pi}{4} = -\frac{\sqrt{2}}{2}$ 2. $\csc\frac{5\pi}{3} = -\frac{2\sqrt{3}}{3}$ 3. $\cot\frac{\pi}{2} = 0$ 4. $\cot\frac{4\pi}{3} = \frac{\sqrt{3}}{3}$ 5. $\sec\frac{5\pi}{6} = -\frac{2\sqrt{3}}{3}$

6. $\cos\frac{11\pi}{6} = \frac{\sqrt{3}}{2}$ 7. $\cot\frac{5\pi}{4} = 1$ 8. $\csc\frac{7\pi}{6} = -2$ 9. $\tan\frac{3\pi}{2} = \text{DNE}$ 10. $\sec\frac{2\pi}{3} = -2$



Congratulations. Take a drink of water. You are now ready for tomorrow's quiz.

TEST - Dr Ahn Math

The given point P is located on the Unit Circle. State the quadrant and find the angle θ, also $\sin\theta$, $\cos\theta$ and $\tan\theta$.

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

Quad:

$\sin\theta$:

$\cos\theta$:

$\tan\theta$:

2) $P(0,-1)$

Quad:

$\sin\theta$:

$\cos\theta$:

$\tan\theta$:

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

Quad:

$\sin\theta$:

$\cos\theta$:

$\tan\theta$:

Find the exact value of each function.

4) $\cos\left(\frac{7\pi}{4}\right)$

5) $\sin\ -30^\circ$

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

7) $\cos(600^\circ)$

8) $\sin\left(\frac{9\pi}{2}\right)$

9) $\tan(7\pi)$

10) $\cos\left(-\frac{11\pi}{4}\right)$

11) $\sin\ -225^\circ$

12) $\tan(585^\circ)$

13) $\cos(1440^\circ)$

14) $\sin\left(-\frac{13\pi}{4}\right)$

15) $\cos\left(\frac{23\pi}{6}\right)$

Unit Circle Worksheet C

Name_____

Period_____

The given point P is located on the Unit Circle. State the quadrant and find the angle θ, also $\sin\theta$, $\cos\theta$ and $\tan\theta$.

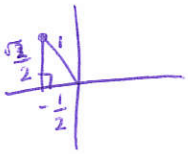
1) $P\left(-\frac{1}{2},\frac{\sqrt{3}}{2}\right)$ (C S)

Quad: 2

$\sin\theta$: $\frac{\sqrt{3}}{2}$

$\cos\theta$: $-\frac{1}{2}$

$\tan\theta$: $-\sqrt{3}$



$\left(\frac{\sqrt{3}}{2}\right)^2+\left(\frac{1}{2}\right)^2$

$\frac{3}{4}+\frac{1}{4}=1$

2) $P(0,-1)$ (C S)

Quad: QUADRANT ANGLE

$\sin\theta$: -1

$\cos\theta$: 0

$\tan\theta$: UND

3) $P\left(\frac{-\sqrt{2}}{2},\frac{-\sqrt{2}}{2}\right)$ (C S)

Quad: 3

$\sin\theta$: $-\frac{\sqrt{2}}{2}$

$\cos\theta$: $-\frac{\sqrt{2}}{2}$

$\tan\theta$: 1

Find the exact value of each function.

4) $\cos\left(\frac{7\pi}{4}\right)$ $\frac{\sqrt{2}}{2}$

5) $\sin -30^\circ$ $-\frac{1}{2}$

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

7) $\cos(600^\circ)$ $-\frac{1}{2}$

5 6 0 − 3 6 0 = 2 4 0

8) $\sin\left(\frac{9\pi}{2}\right)$ 1

9) $\tan(7\pi)$ 0

10) $\cos\left(-\frac{11\pi}{4}\right)$ $-\frac{\sqrt{2}}{2}$

11) $\sin -225^\circ$ $\frac{\sqrt{2}}{2}$

12) $\tan(585^\circ)$ 1

5 8 5 − 3 6 0 = 2 2 5

13) $\cos(1440^\circ)$ 1

1 4 4 0 − 7 2 0 = 7 2 0

14) $\sin\left(-\frac{13\pi}{4}\right)$ $\frac{\sqrt{2}}{2}$

15) $\cos\left(\frac{23\pi}{6}\right)$ $\frac{\sqrt{3}}{2}$