Online Learning Classroom
e-BRIGHT ACADEMY

Trigonometric ratio

9-Grade

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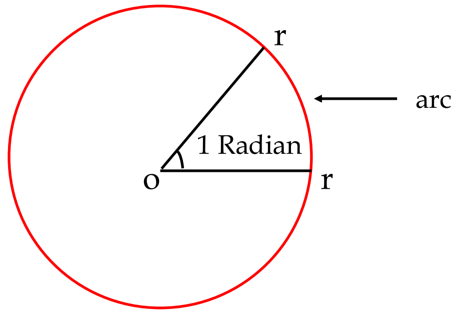
Radian and degree measure

⇒ <u>**Radian**</u> - S.1 Unit of angle.

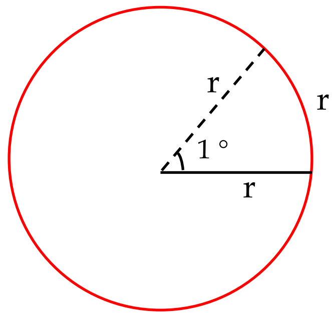
Arc of a circle = Radius of a circle.



1 Radian = Angle subtended at the center by an arc of length equal to the radius.

radius ↓

arc length → $s = r\,\theta$ ← angle

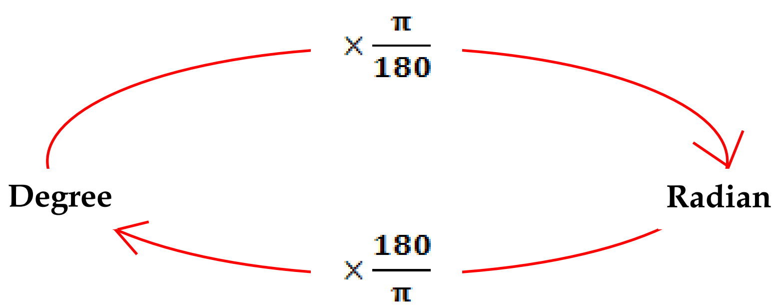


π Radian is equivalent to 180° degrees.

Practice - Conversion from degrees to radian.

Degree	Radian
30°	$\frac{\pi}{6}^{c}$
45°	$\frac{\pi}{4}^{c}$
60°	$\frac{\pi}{3}^{c}$
90°	$\frac{\pi}{2}^{c}$
180°	$\frac{2\pi}{3}^{c}$
135°	$3\frac{\pi}{4}^{c}$

Remember :



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To Convert Degree to Radian

- If to convert degree into radian multiply by $\frac{\pi}{180}$

$$\textbf{Degree} \xrightarrow{\times \frac{\pi}{180}} \textbf{Radian}$$

Q. Convert degree to radian.

1. $60°$

Ans : $6\cancel{0} \times \frac{\pi}{18\cancel{0}}$

$$= \overset{1}{\cancel{6}} \times \frac{\pi}{\underset{3}{\cancel{18}}}$$

$$= \frac{\pi}{3}^{c}$$

$$\boxed{\therefore\ 60° = \frac{\pi}{3}^{c}}$$

2. $30°$

Ans : $3\cancel{0} \times \frac{\pi}{18\cancel{0}}$

$$= \overset{1}{\cancel{3}} \times \frac{\pi}{\underset{6}{\cancel{18}}}$$

$$= \frac{\pi}{6}^{c}$$

$$\boxed{\therefore\ 30° = \frac{\pi}{6}^{c}}$$

Notes :

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3. 45°

Ans : $45 \times \frac{\pi}{180}$

$$= \overset{9}{\cancel{45}} \times \frac{\pi}{\underset{36}{\cancel{180}}}$$

$$= \overset{1}{\cancel{9}} \times \frac{\pi}{\underset{4}{\cancel{36}}}$$

$$= 1 \times \frac{\pi}{4}$$

$$= \frac{\pi}{4}^{c}$$

$$\boxed{\therefore\ 45^\circ = \frac{\pi}{4}^{c}}$$

4. 90°

Ans : $\cancel{90} \times \frac{\pi}{\cancel{180}}$

$$= \overset{1}{\cancel{9}} \times \frac{\pi}{\underset{2}{\cancel{18}}}$$

$$= \frac{\pi}{2}^{c}$$

$$\therefore\ 90^\circ = \frac{\pi}{2}^{c}$$

Notes :

5. 180°

Ans : $\cancel{180} \times \frac{\pi}{\cancel{180}}$

$= \pi^{c}$

$$\boxed{\therefore 180° = \pi^{c}}$$

6. 135°

Ans : $135 \times \frac{\pi}{180}$

$= \overset{3}{\cancel{27}} \times \frac{\pi}{\underset{4}{\cancel{36}}}$

$= 3 \times \frac{\pi}{4}$

$= \frac{3\pi^{c}}{4}$

$$\boxed{\therefore 135° = \frac{3\pi^{c}}{4}}$$

7. 225°

Ans : $225 \times \frac{\pi}{180}$

$= \overset{5}{\cancel{45}} \times \frac{\pi}{\underset{4}{\cancel{36}}}$

$= 5 \times \frac{\pi}{4}$

$= \frac{5\pi^{c}}{4}$

$$\boxed{\therefore 225° = \frac{5\pi^{c}}{4}}$$

Notes :

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8. $190°$

Ans : $19\cancel{0} \times \frac{\pi}{18\cancel{0}}$

$= \frac{19\pi}{18}^{c}$

$$\boxed{\therefore 190° = \frac{19\pi}{18}^{c}}$$

To Convert Radian to Degree

- If to convert radian into degree multiply by $\frac{180}{\pi}$

$$\text{Radian} \xrightarrow{\frac{180}{\pi}} \text{Degree}$$

Q. Convert radian to degree.

1. $\frac{\pi}{3}^{c}$

Ans : $\frac{\cancel{\pi}}{3} \times \frac{180}{\cancel{\pi}}$

$= \frac{\cancelto{60}{180}}{\cancelto{1}{3}}$

$= 60°$

$$\boxed{\therefore \frac{\pi}{3}^{c} = 60°}$$

2. $\frac{\pi}{6}^{c}$

Ans : $\frac{\cancel{\pi}}{6} \times \frac{180}{\cancel{\pi}}$

$= \frac{\overset{30}{\cancel{180}}}{\underset{1}{\cancel{6}}}$

$= 30°$

$\boxed{\therefore \frac{\pi}{6}^{c} = 30°}$

3. $\frac{\pi}{4}^{c}$

Ans : $\frac{\cancel{\pi}}{4} \times \frac{180}{\cancel{\pi}}$

$= \frac{\overset{45}{\cancel{180}}}{\underset{1}{\cancel{4}}}$

$= 45°$

$\boxed{\therefore \frac{\pi}{4}^{c} = 45°}$

4. $\frac{\pi}{2}^{c}$

Ans : $\frac{\cancel{\pi}}{2} \times \frac{180}{\cancel{\pi}}$

$= \frac{\overset{90}{\cancel{180}}}{\underset{1}{\cancel{2}}}$

$= 90°$

$\boxed{\therefore \frac{\pi}{2}^{c} = 90°}$

Notes :

5. π^c

Ans : $\cancel{\pi} \times \frac{180}{\cancel{\pi}}$

$= 180^\circ$

$\boxed{\therefore \pi^c = 180^\circ}$

---

6. $\frac{3\pi}{4}^c$

Ans : $\frac{3\cancel{\pi}}{4} \times \frac{180}{\cancel{\pi}}$

$= \frac{3}{\cancel{4}_1} \times \cancel{180}^{45}$

$= 3 \times 45$

$= 135^\circ$

$\boxed{\therefore \frac{3\pi}{4}^c = 135^\circ}$

---

7. $\frac{5\pi}{4}^c$

Ans : $\frac{5\cancel{\pi}}{4} \times \frac{180}{\cancel{\pi}}$

$= \frac{5}{\cancel{4}_1} \times \cancel{180}^{45}$

$= 5 \times 45$

$= 225^\circ$

$\boxed{\therefore \frac{5\pi}{4}^c = 225^\circ}$

Notes :

8. $\frac{2}{5}\pi^{c}$

Ans : $\frac{2}{5}\cancel{\pi} \times \frac{180}{\cancel{\pi}}$

$= \frac{2}{\cancel{5}_{1}} \times \cancel{180}^{36}$

$= 2 \times 36$

$= 72°$

$\boxed{\therefore \frac{2}{5}\pi^{c} = 72°}$

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Trigonometric Ratios

$$\text{Sin } \theta = \frac{\text{Opposite Side of } \measuredangle\, \theta}{\text{Hypotenuse}}$$

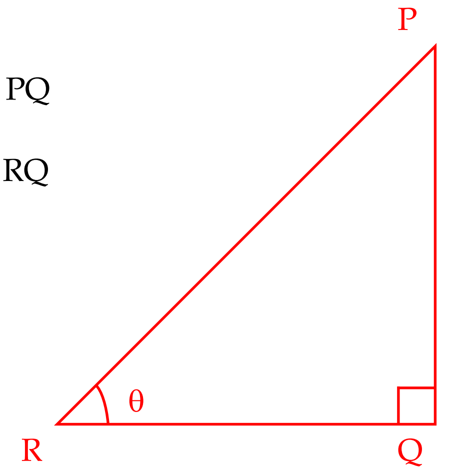
$$\cos \theta = \frac{\text{Adjasent Side of } \measuredangle\, \theta}{\text{Hypotenuse}}$$

$$\tan \theta = \frac{\text{Opposite Side of } \measuredangle\, \theta}{\text{Adjasent Side of } \measuredangle\, \theta}$$

Opposite Side of $\measuredangle\theta$ = PQ

Adjacent Side of $\measuredangle\theta$ = RQ

Hypotenuse = RP



Trigonometric Ratios of 0°, 30°, 45°, 60° and 90°

Trigonometric Table

Degree →	**0°**	**30°**	**45°**	**60°**	**90°**
Radian →	0	$\frac{\pi}{6}^c$	$\frac{\pi}{4}^c$	$\frac{\pi}{3}^c$	$\frac{\pi}{2}^c$
Sin	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	**1**
Cos	0	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
Tan	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	Not Defined
Cosec	Not Defined	2	$\sqrt{2}$	$\frac{2}{\sqrt{3}}$	1
Sec	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	2	Not Defined
Cot	Not Defined	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0

Notes :

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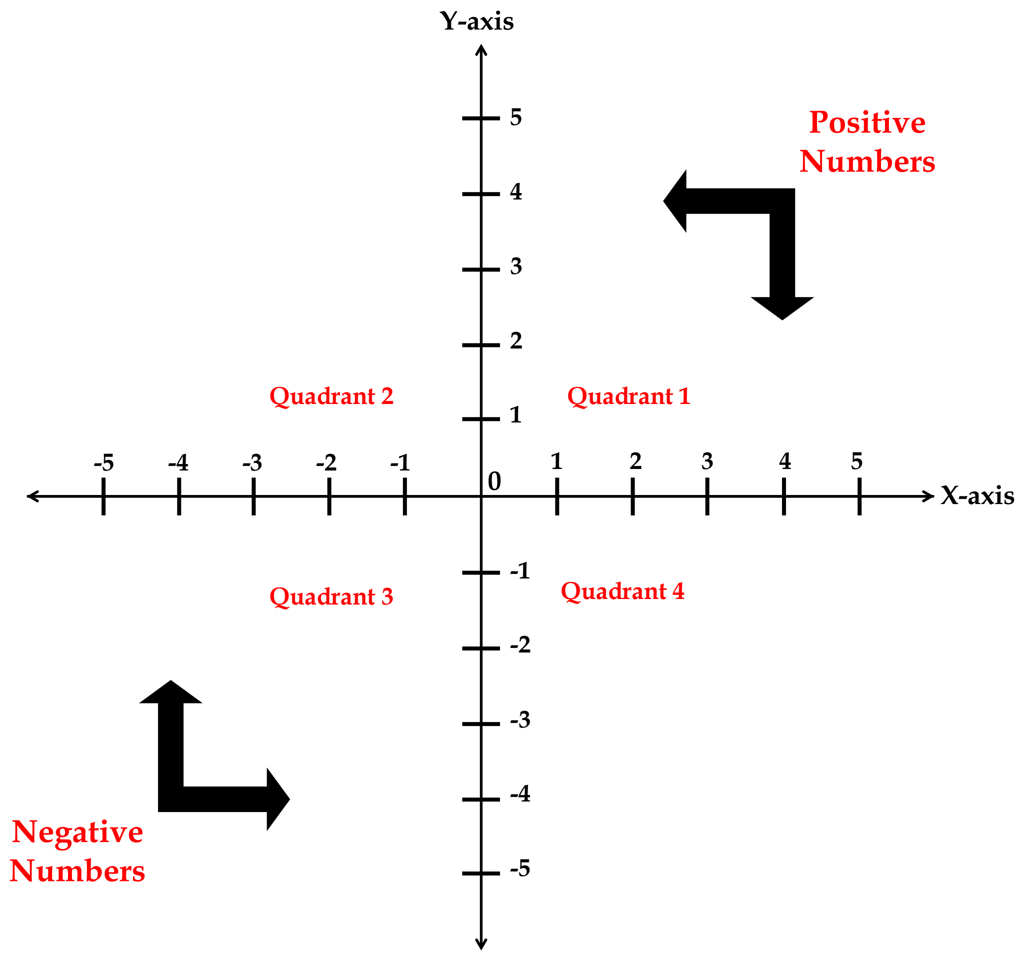
Remember :



sin θ

cos θ

tan θ

cot θ

sec θ

cosec θ

$$\sin\theta = \frac{1}{\operatorname{cosec}\theta}$$

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

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

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

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

$$\operatorname{cosec}\theta = \frac{1}{\sin\theta}$$

Notes :

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- **The relation between the trigonometric ratios.**

1. $\operatorname{cosec}\theta = \dfrac{1}{\sin\theta}$

   $\therefore \sin\theta \times \operatorname{cosec}\theta = 1$

2. $\sec\theta = \dfrac{1}{\cos\theta}$

   $\therefore \sec\theta \times \cos\theta = 1$

3. $\cot\theta = \dfrac{1}{\tan\theta}$

   $\therefore \cot\theta \times \tan\theta = 1$

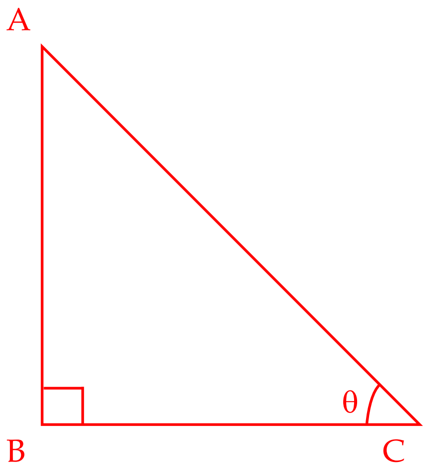
4. $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$

5. $\cot\theta = \dfrac{\cos\theta}{\sin\theta} = \dfrac{1}{\tan\theta}$

Trigonometric identities.

1. In Δ ABC,

   $\angle B = 90^{\circ}, \angle C = \theta$



Ans : $\therefore AB^2 + BC^2 = AC^2$ ——— (Pythagoras theorem)

$= \dfrac{AB^2}{AC^2} + \dfrac{BC^2}{AC^2} = \dfrac{AC^2}{AC^2}$ ——— (Dividing both sides by AC^2)

$= \left(\dfrac{AB}{AC}\right)^2 + \left(\dfrac{BC}{AC}\right)^2 = 1$

$= \therefore (\sin\theta)^2 + (\cos\theta)^2 = 1$

$= \left[\therefore \dfrac{AB}{AC} = \sin\theta \text{ and } \dfrac{BC}{AC} = \cos\theta\right]$

$$\boxed{\therefore \sin^2\theta + \cos^2\theta = 1}$$

Notes :

2. $\sin^2\theta + \cos^2\theta = 1$

Ans : $\therefore \frac{\sin^2\theta}{\sin^2\theta} + \frac{\cos^2\theta}{\sin^2\theta} = \frac{1}{\sin^2\theta}$ – – –(Dividing both sides by $\sin^2\theta$)

$\therefore 1 + (\cot\theta)^2 = (\operatorname{cosec}\theta)^2$

$\left[\therefore \frac{\cos\theta}{\sin\theta} = \cot\theta \text{ and } \frac{1}{\sin\theta} = \operatorname{cosec}\theta\right]$

$\boxed{\therefore 1 + \tan^2\theta = \sec^2\theta}$

3. $\sin^2\theta + \cos^2\theta = 1$

Ans : $\therefore \frac{\sin^2\theta}{\cos^2\theta} + \frac{\cos^2\theta}{\cos^2\theta} = \frac{1}{\cos^2\theta}$ – (Dividing both sides by $\cos^2\theta$)

$\therefore \left(\frac{\sin\theta}{\cos\theta}\right)^2 + 1 = \left(\frac{1}{\cos\theta}\right)^2$

$\therefore (\tan\theta)^2 + 1 = (\sec\theta)^2$

$\left[\therefore \frac{\sin\theta}{\cos\theta} = \tan\theta \text{ and } \frac{1}{\cos\theta} = \sec\theta\right]$

$\therefore 1 + \tan^2\theta = \sec^2\theta$

Note : $(\sin\theta)^2$ is written as $\sin^2\theta$,
$(\cos\theta)^2$ is written as $\cos^2\theta$ and so on.

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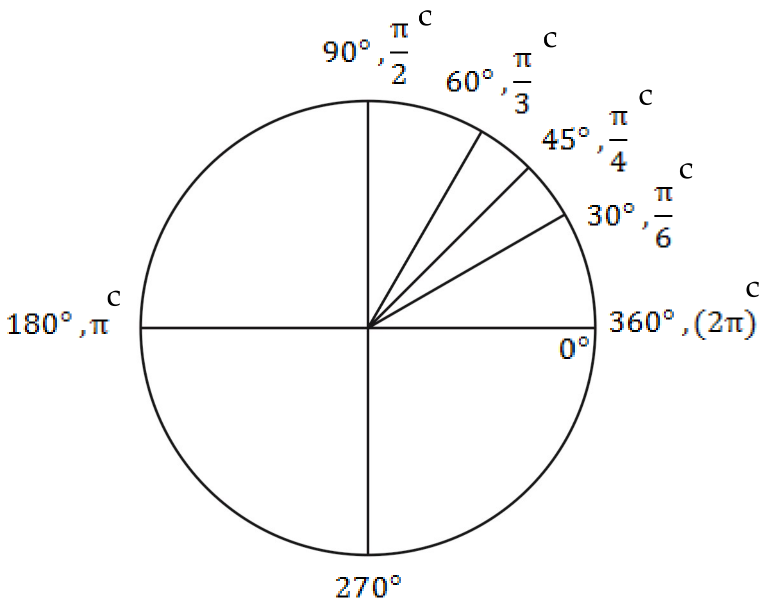
- Trigonometric function the units circle.



Basic concept

1. 30° - 60° - 90° Triangle

Ans : $\sin(30°) = \frac{1}{2}$

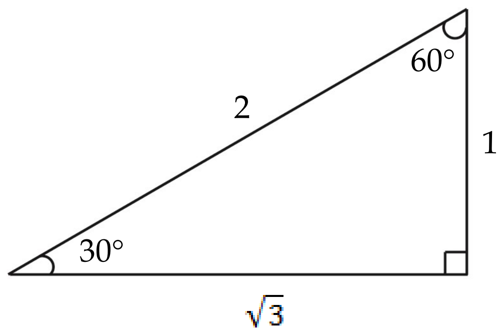
$= \cos(30°) = \frac{\sqrt{3}}{2}$

$= \tan(30°) = \frac{\sin(30°)}{\cos(30°)}$

$$= \frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}}$$

$$= \frac{1}{\cancel{2}} \times \frac{\cancel{2}}{\sqrt{3}}$$

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



Notes :

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2. 45° - 45° - 90° Triangle

Ans : $\sin(45^\circ) = \frac{1}{\sqrt{2}}$

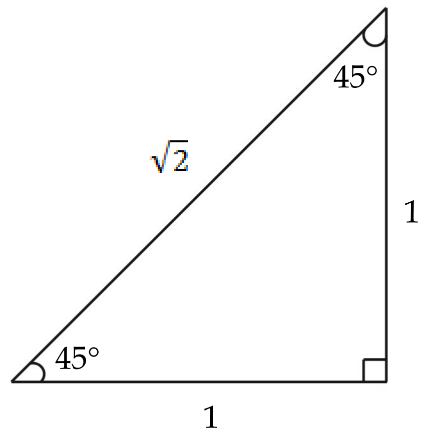
$= \cos(45^\circ) = \frac{1}{\sqrt{2}}$

$= \tan(45^\circ) = \frac{\sin(45^\circ)}{\cos(45^\circ)}$

$= \frac{\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{2}}}$

$= \frac{1}{\cancel{\sqrt{2}}} \times \frac{\cancel{\sqrt{2}}}{1}$

$= 1$



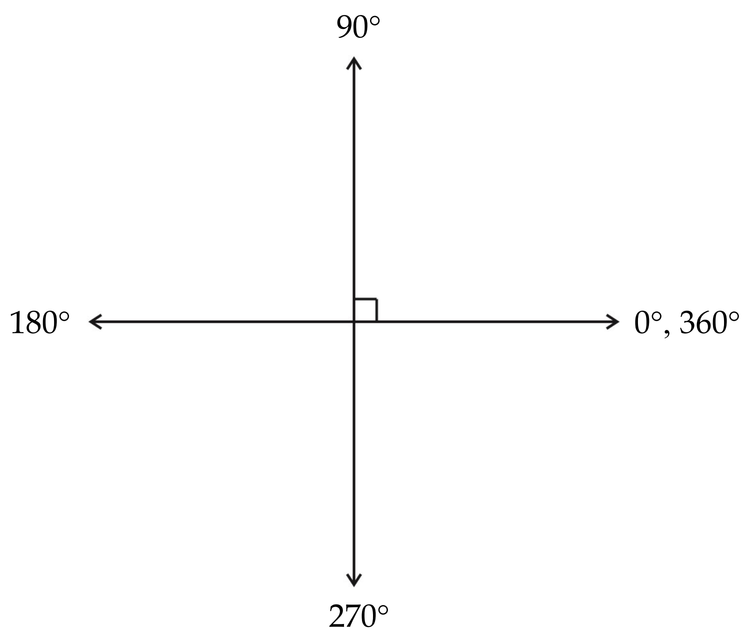
Note :

Quarter 1 = θ_1

Quarter 2 = $180^\circ - \theta_2$

Quarter 3 = $\theta_3 - 180^\circ$

Quarter 4 = $360^\circ - \theta_4$



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Q. Find the value of sin (120°)

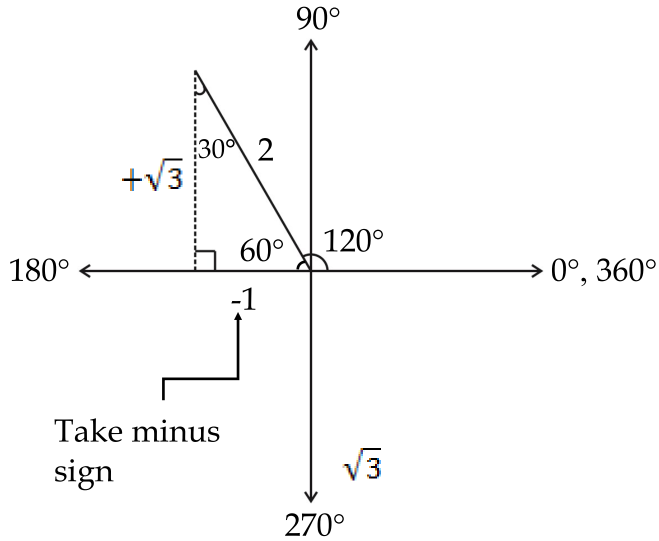
Ans : sin (120°)

= sin (180°-120°)

= sin (60°)

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

$$\boxed{\therefore \sin(120^\circ) = \frac{\sqrt{3}}{2}}$$



Q. Find the value of cos (240°)

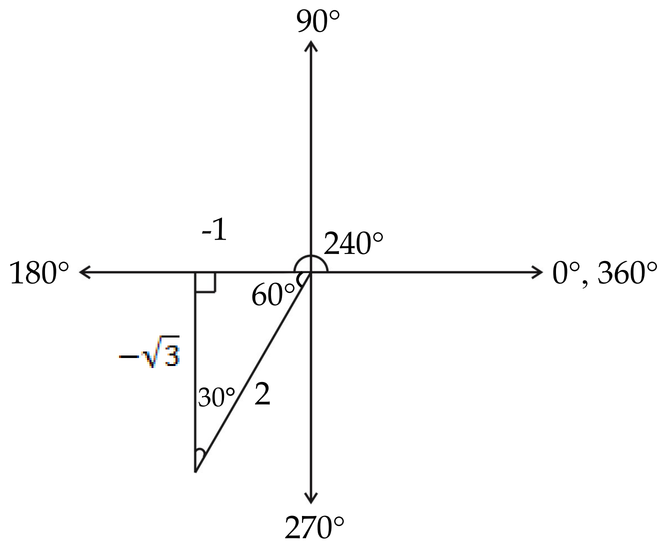
Ans : cos (240°)

= cos (240°- 180°)

= cos 60°

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

$$\boxed{\therefore \cos(240^\circ) = \frac{-1}{2}}$$



Q. Find the value of tan (330°)

Ans : tan (330°)

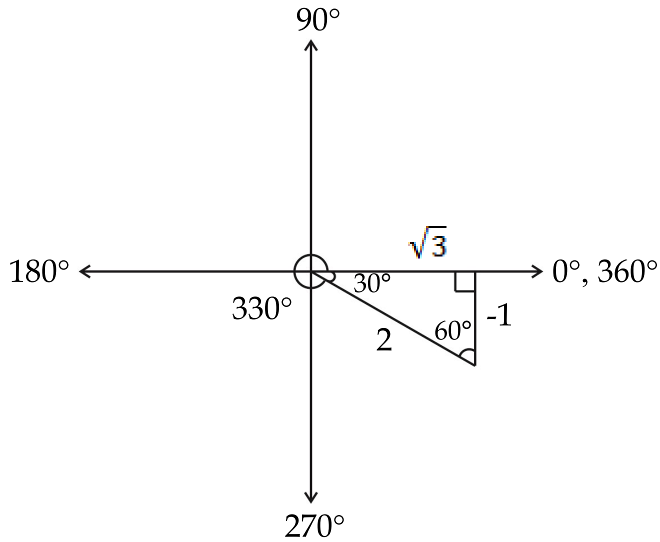
= tan (360°- θ)

= tan (360°- 330°)

= tan (30°)

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

$$\boxed{\therefore \tan(330^\circ) = \frac{-1}{\sqrt{3}}}$$



Notes :

Q. Find the value of cos (225°)

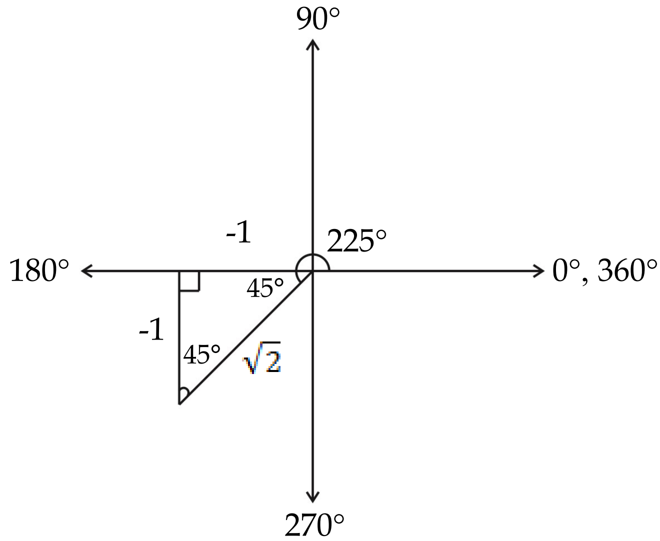
Ans : cos (225°)

= cos (225°- 180°)

= cos (45°)

$= \frac{-1}{\sqrt{2}}$

$\boxed{\therefore \cos(225^\circ) = \frac{-1}{\sqrt{2}}}$



Q. Find the value of tan (90°)

Ans : tan (90°)

$= \frac{\sin(90^\circ)}{\cos(90^\circ)}$

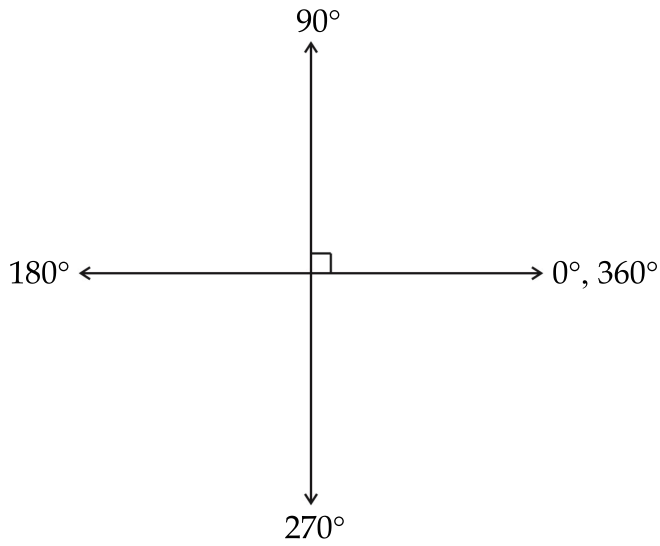
$= \frac{1}{0}$

$\boxed{\therefore \text{ Undefined}}$

Fixed value

sin 90° = 1

cos 90° = 0



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Q. Find $\sin\left(\frac{5\pi}{6}\right)$ ⟵ (Angle in radians)

Ans : $\frac{5\cancel{\pi}}{6} \times \frac{180°}{\cancel{\pi}}$ (Convert the radian angle into a degree.)

$= \frac{5 \times \overset{30}{\cancel{180}}}{\underset{1}{\cancel{6}}}$

$= 5 \times 30$

$= 150°$

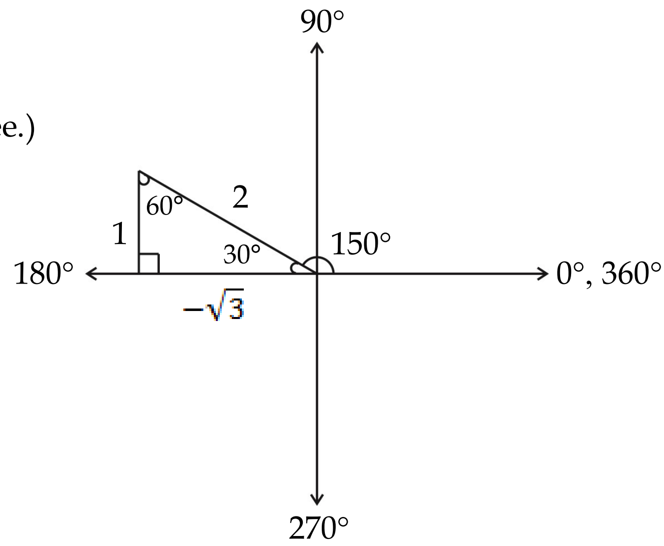
$= \sin(150°)$

$= \sin(180° - 150°)$

$= \sin(30°)$

$= \frac{1}{2}$

$$\boxed{\therefore \sin\left(\frac{5\pi}{6}\right) = \sin(150°) = \frac{1}{2}}$$



Q. Find $\cos \frac{11\pi}{6}$

Ans : $\frac{11\cancel{\pi}}{6} \times \frac{180°}{\cancel{\pi}}$ (Convert the radian angle into a degree.)

$= \frac{11 \times \overset{30}{\cancel{180}}}{\underset{1}{\cancel{6}}}$

$= 11 \times 30$

$= 330°$

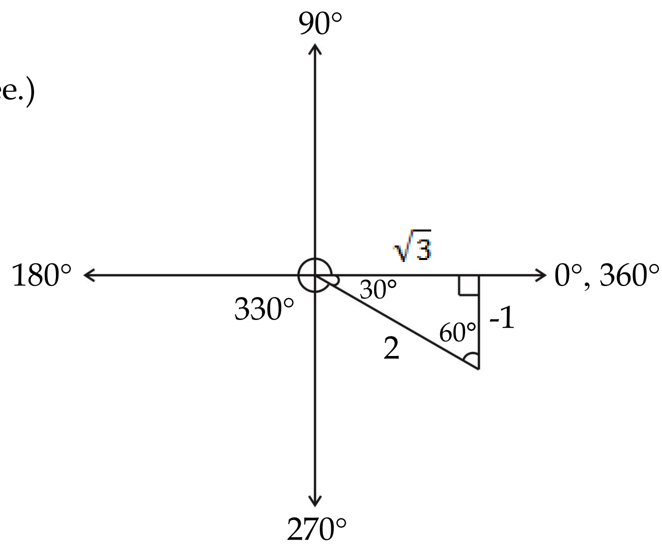
$= \cos\left(\frac{11\pi}{6}\right) = \cos(330°)$

$= \cos(330°)$

$= \cos(360° - 330°)$

$= \cos(30°)$

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



$$\boxed{\therefore \cos\left(\frac{11\pi}{6}\right) = \cos(330°) = \frac{-\sqrt{3}}{2}}$$

Notes :

Q. Find tan (-150°)

Ans : tan (-150°)

(Convert negative angle into positive angle.)

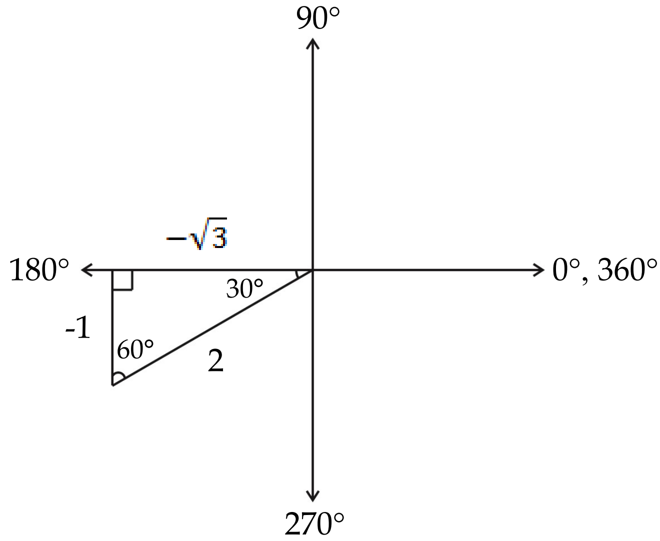
= -150° + 360°

= 210°

= tan (210°)

= tan (210°-180°)

= tan (30°)



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

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

$\boxed{\therefore \tan(-150^\circ) = \frac{1}{\sqrt{3}}}$

Q. Find the value of sec (300°)

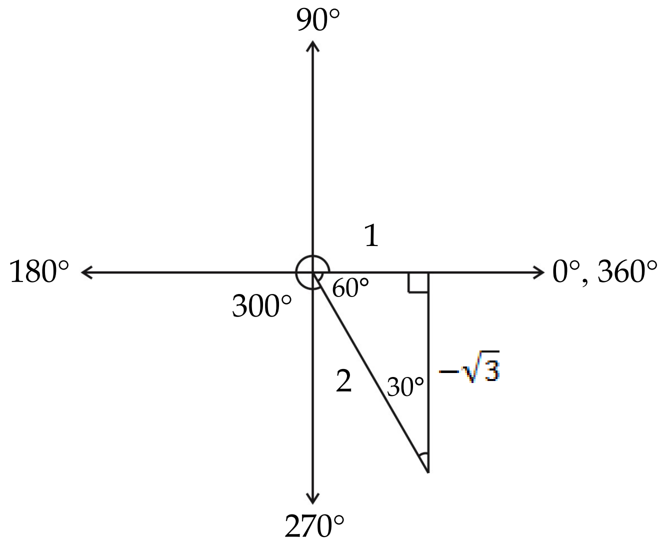
Ans : we know that

= $\sec\theta = \frac{1}{\cos\theta}$,

= $\sec(300^\circ) = \frac{1}{\cos(300^\circ)}$

= cos (360° - 300°)

= cos (60°)



= $\sec 60 = \frac{1}{\cos(60)}$

= $\frac{1}{\frac{1}{2}}$

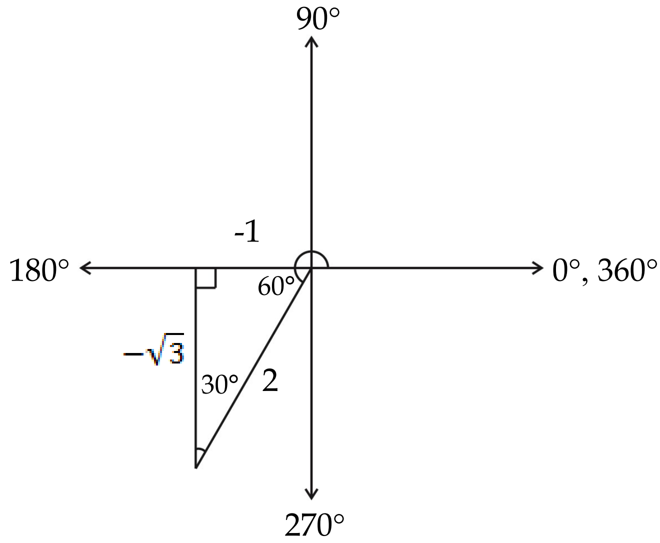
Notes :

$= \quad \sec(60°) = \frac{2}{1}$

$\boxed{\therefore \quad \sec(300°) = 2}$

Q. Find the value of sec (240°)

Ans : we know that



$= \quad \text{cosec}\,\theta = \frac{1}{\sin\theta}$

$= \quad \text{cosec}\,(240°) = \frac{1}{\sin(240°)}$

$= \quad \sin(240°)$

$= \quad \sin(240° - 180°)$

$= \quad \sin(60°)$

$= \quad \sin(60°) = \frac{-\sqrt{3}}{2}$

$= \quad \text{cosec}(240°) = \frac{1}{\sin(60°)}$

$= \quad \frac{1}{\frac{-\sqrt{3}}{2}}$

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

$\boxed{\therefore \ \text{cosec}(240°) = \frac{-2}{\sqrt{3}}}$

Q. Find the value of cot (600°)

Ans : 600° is long angle, subtract 360° from 600°

$= 600° - 360°$

$= 240°$

$= \cot 600° = \cot 240°$

$= \cot (240°)$

$= \cot (240° - 180°)$

$= \cot (60°)$

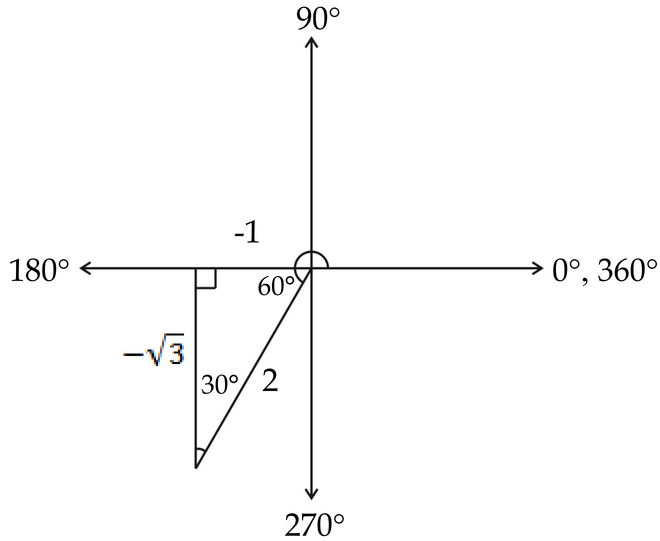
$$= \frac{\cos (60°)}{\sin (60°)}$$

$$= \frac{\frac{-1}{2}}{\frac{-\sqrt{3}}{2}}$$

$$= \frac{\cancel{-}1}{\cancel{2}} \times \frac{\cancel{2}}{\cancel{-}\sqrt{3}}$$

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

$$\boxed{\therefore \cot(600°) = \frac{1}{\sqrt{3}}}$$



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