

# Trigonometric Functions

## Case Study Based Questions

Read the following passages and answer the questions that follow:

1. Nitish is playing with a Pinwheel toy which he bought from a village fair. He noticed that the pinwheel toy revolves as fast as he blows it. Consider the Pinwheel toy that makes 360 revolutions per minute.



- (A) Find the number of revolutions made by Pinwheel toy in 120 second.  
(B) Find the number of revolutions made by Pinwheel toy in 1 sec and angle made by Pinwheel toy (in degree) in 6 revolutions.  
(C) Find the radius of the circle in which a central angle of  $60^\circ$  intercepts an arc of length 37.4 cm. (Use  $\pi = \frac{22}{7}$ ).

**Ans.** (A) Since the number of revolutions made by

Pinwheel toy in 1 minute = 360

And 1 min 60 seconds

So, the number of revolution made by Pinwheel toy in 60 seconds = 360

The number of revolution made by Pinwheel

$$\text{toy in 1 second} = \frac{360}{60}$$

Number of revolutions made by Pinwheel

$$\text{toy in 120 seconds} = \frac{360 \times 120}{60} = 720$$

(B) The number of revolution made by Pinwheel



$$\text{toy in 1 seconds} = \frac{360}{60} = 6$$

Since, angle made by Pinwheel toy in 1 revolutions =  $360^\circ$ .

Thus, angle made by Pinwheel toy in 6 revolutions  $360^\circ \times 6 = 2160^\circ$

(C) Given,

Length of the arc =  $l = 37.4$  cm

$$\text{Central angle} = \theta = 60^\circ = \frac{60 \times \pi}{180} \text{ radian}$$

$$= \frac{\pi}{3} \text{ radians}$$

We know that,

$$r = \frac{l}{\theta}$$

$$= (37.4) \times \left( \frac{\pi}{3} \right)$$

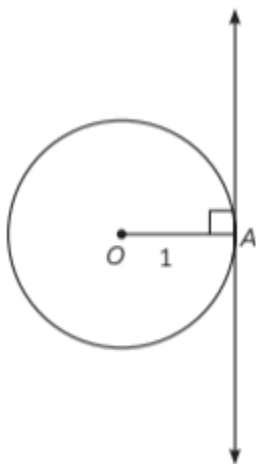
$$= \frac{(37.4)}{\left( \frac{22}{7 \times 3} \right)}$$

$$= 35.7 \text{ cm}$$

Hence, the radius of the circle is 35.7 cm.

2. Consider a unit circle with centre O. Let A be any point on the circle. Consider O A as the initial side of an angle. Then the length of an arc of the circle will give the radian measure of the angle which the arc will subtend at the centre of the circle.

A circle subtends an angle at the centre whose radian measure is  $2\pi$  and its degree measure is  $360^\circ$



(A) The radian measure of  $240^\circ$  is:



(a)  $\frac{4\pi}{3}$

(b)  $\frac{2\pi}{3}$

(c)  $\frac{5\pi}{3}$

(d)  $\frac{\pi}{3}$

**(B) A wheel makes 360 revolutions in one minute. Through how many radians does it turn in one second?**

- (a)  $6\pi$
- (b)  $4\pi$
- (c)  $3\pi$
- (d)  $12\pi$

**(C) The degree measure of 1.2 radian is:**

- (a)  $68^\circ$
- (b)  $68^\circ 43' 37.8''$
- (c)  $68^\circ 45' 36''$
- (d)  $58^\circ 46' 27''$

**(D) The radius of the circle in which a central angle of  $45^\circ$  intercepts an arc of 132 cm, is:**

(Use  $\pi = \frac{22}{7}$ )

- (a) 168 cm
- (b) 50 cm
- (c) 160 cm
- (d) 148 cm

**(E) The minute hand of a watch is 35 cm long. How far does it move in 9 minutes?**

- (a) 15 cm
- (b) 30 cm
- (c) 46 cm
- (d) 33 cm

**Ans. (A)**

(a)  $\frac{4\pi}{3}$



**Explanation:** As we know that

$$180^\circ = \text{radian}$$

$$1^\circ = \frac{\pi}{180^\circ} \text{ radian}$$

$$\begin{aligned}\text{Radian measure of } 240^\circ &= 240 \times \frac{\pi}{180^\circ} \\ &= \frac{4\pi}{3}\end{aligned}$$

**(B)** (d)  $12\pi$

**Explanation:** Given that a wheel makes 360 revolutions in 1 minute. i.e., a wheel makes 360 revolutions in 60 seconds.

$$\therefore \text{In 1 second, no. of revolutions} = \frac{360}{60}$$

= 6 revolutions

In 1 revolution, the angle made by the wheel

$$= 360^\circ$$

$\therefore$  Angle made by the wheel in 6 revolutions

$$= 6 \times 360^\circ$$

$$= 2160^\circ$$

Radian made in 6 revolutions

$$= 2160^\circ \times \frac{\pi}{180^\circ}$$

$$= 12\pi$$

**(C)** (b)  $68^\circ 43' 37.8''$

**Explanation:** As we know that,

$$180^\circ = \pi \text{ radian}$$

$$1 \text{ radian} = \frac{180^\circ}{\pi}$$

$$(1.2) = \left( 1.2 \times \frac{180}{\pi} \right)$$

$$= 1.2 \times \frac{180}{22} \times 7$$

$$= 68.7272^\circ$$

$$= 68^\circ (0.7272 \times 60)'$$

$$= 68^\circ 43'(0.63 \times 60)''$$



$$= 68^\circ 43' 37.8''$$

**(D)** (a) 168 cm

**Explanation:** We have,

$$l = 132 \text{ cm and } \theta = 45^\circ = 45 \times \frac{\pi}{180} = \frac{\pi}{4}$$

$$\text{Now, } \theta = \frac{l}{r} = \frac{132}{r}$$

$$\frac{\pi}{4} = \frac{132}{r}$$

$$\Rightarrow r = \frac{132 \times 4}{\pi}$$

$$\Rightarrow r = \frac{132 \times 4}{\frac{22}{7}} = 168 \text{ cm}$$

**(E)** (d) 33 cm

**Explanation:** The angle made by minute hand in 9 minutes =  $(9 \times 6)^\circ$

$$= 54^\circ = 54^\circ \times \frac{\pi}{180} = \frac{3\pi}{10}$$

$$\therefore \theta = \frac{l}{r}$$

$$\Rightarrow \frac{3\pi}{10} = \frac{l}{35}$$

$$\Rightarrow l = \frac{35 \times 3\pi}{10} = \frac{21\pi}{2}$$

$$\Rightarrow l = \frac{21}{2} \times \frac{22}{7} = 33 \text{ cm}$$

**3.** Sudhir who is a student of class XI got a Maths assignment from his class teacher. He did all the questions except a few. If the value

$$\text{of } \sin x = \frac{3}{5} \text{ and } \cos y = -\frac{12}{13}, \text{ where } x \text{ and } y$$

both lie in the second quadrant, then help Sudhir in solving these questions.





**(A) What will be the value of  $\cos x$ ?**

(a)  $\frac{4}{5}$

(b)  $\frac{-3}{5}$

(c)  $\frac{-4}{5}$

(d)  $\frac{3}{5}$

**(B) What will be the value of  $\sin y$ ?**

(a)  $\frac{5}{12}$

(b)  $\frac{-12}{13}$

(c)  $\frac{-5}{13}$

(d)  $\frac{5}{13}$

**(C) Which of the following options is correct?**

(a)  $\sin(x - y) = \sin x \cos y + \cos x \sin y$

(b)  $\sin(x + y) = \cos x \sin y - \sin x \cos y$

(c)  $\sin(x + y) = \sin x \cos y + \cos x \sin y$

(d)  $\sin(x - y) = \sin x \sin y - \cos x \cos y$

**(D) The value of  $\sin(x + y)$  is:**

(a)  $\frac{-56}{65}$

(b)  $\frac{56}{65}$

(c)  $\frac{55}{67}$

(d)  $\frac{-55}{67}$

**(E) The value of  $\sin 75^\circ$  is:**

(a)  $\frac{1 - \sqrt{3}}{\sqrt{2}}$

(b)  $\frac{1 + \sqrt{3}}{2\sqrt{2}}$

(c)  $\frac{1 - \sqrt{3}}{2\sqrt{2}}$

(d)  $\frac{1 + \sqrt{3}}{2}$



**Ans. (A)**

(c)  $\frac{-4}{5}$

**Explanation:** Given,  $\sin x = \frac{3}{5}$

As we know that

$$\begin{aligned}\cos^2 x &= 1 - \sin^2 x \\ &= 1 - \left(\frac{3}{5}\right)^2 \\ &= 1 - \frac{9}{25} \\ &= \frac{25-9}{25} = \frac{16}{25}\end{aligned}$$

Thus,  $\cos x = \pm \frac{4}{5}$

Since  $x$  lies in second quadrant

$\therefore \cos x$  is negative

$\therefore \cos x = -\frac{4}{5}$

(B) (d)  $\frac{5}{13}$

**Explanation:** Given,

$$\cos y = \frac{-12}{13}$$

As we know that

$$\begin{aligned}\sin^2 y &= 1 - \cos^2 y \\ &= 1 - \frac{144}{169} = \frac{25}{169} = \pm \frac{5}{13}\end{aligned}$$

Since,  $y$  lies in second quadrant

$\therefore \sin y$  is positive

$\therefore \sin y = \frac{5}{13}$

**(C)** (c)  $\sin(x + y) = \sin x \cos y + \cos x \sin y$

**Explanation:** Trigonometric function of compound angle

$$\sin(x + y) = \sin x \cos y + \cos x \sin y$$



(D) (a)  $\frac{-56}{65}$

**Explanation:**

As we know that

$$\sin(x + y) = \sin x \cos y + \cos x \sin y$$

$$\begin{aligned}\sin(x + y) &= \left(\frac{3}{5}\right) \times \left(-\frac{12}{13}\right) + \left(-\frac{4}{5}\right) \times \left(\frac{5}{13}\right) \\ &= -\frac{36}{65} - \frac{20}{65} = -\frac{56}{65}\end{aligned}$$

(E)

(b)  $\frac{1 + \sqrt{3}}{2\sqrt{2}}$

**Explanation:** Given,

$$\begin{aligned}\sin 75^\circ &= \sin(30^\circ + 45^\circ) \\ &= \sin 30^\circ \cos 45^\circ + \cos 30^\circ \sin 45^\circ \\ &= \frac{1}{2} \cdot \frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2} \cdot \frac{1}{\sqrt{2}} = \frac{1 + \sqrt{3}}{2\sqrt{2}}\end{aligned}$$

4.

Consider  $\sin A = \frac{4}{5}$  and  $\cos B = \frac{5}{13}$  where

$$0 < A, B < \frac{\pi}{2}.$$

(A) Find the value of  $\cos A + \sin B$ .

(B) Find value of  $\cos(A + B)$ .

(C) Find the value of  $\sin(A - B)$ .



**Ans.**

(A) Given,  $\sin A = \frac{4}{5}, 0 < A < \frac{\pi}{2}$

$$\therefore \cos A = \sqrt{1 - \sin^2 A}$$

[ $\because$  A lies in 1st quadrant]

$$= \sqrt{1 - \left(\frac{4}{5}\right)^2} = \sqrt{1 - \frac{16}{25}}$$

$$\Rightarrow \cos A = \sqrt{\frac{9}{25}} = \frac{3}{5}$$

And  $\cos B = \frac{5}{13}, 0 < B < \frac{\pi}{2}$

$$\therefore \sin B = \sqrt{1 - \cos^2 B}$$

[ $\because$  B lies in 1st quadrant]

$$= \sqrt{1 - \left(\frac{5}{13}\right)^2} = \sqrt{1 - \frac{25}{169}}$$

$$\Rightarrow \sin B = \sqrt{\frac{144}{169}} = \frac{12}{13}$$

$$\cos A + \sin B = \frac{3}{5} + \frac{12}{13} = \frac{39 + 60}{65} = \frac{99}{65}$$

**(B)**  $\cos (A+B) = \cos A \cos B - \sin A \sin B$

$$= \frac{3}{5} \times \frac{5}{13} - \frac{4}{5} \times \frac{12}{13}$$

$$= \frac{15 - 48}{65} = \frac{-33}{65}$$

**(C)**  $\sin (A - B) = \sin A \cos B - \cos A \sin B$

$$= \frac{4}{5} \times \frac{5}{13} - \frac{3}{5} \times \frac{12}{13}$$

$$= \frac{20 - 36}{65} = \frac{-16}{65}$$