

# L<sup>A</sup>T<sub>E</sub>X 9.10.6.7

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CLASS 9, CHAPTER, 10, EXERCISE 6.7

Q. AC and BD are chords of a circle which bisect each other. Prove that (i) AC and BD are diameters, (ii) ABCD is a rectangle.

**Solution:** Let, we have a unit circle with center at origin, i.e.  $\mathbf{O} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ , and radius  $r = 1$ . Let's consider points A, B, C and D on the circle such that AC and BD are diameter of the circle. The points on circle that we consider are available in Table (I).

<b>A</b>	$\begin{pmatrix} \cos 0 \\ \sin 0 \end{pmatrix}$	$\begin{pmatrix} 1 \\ 0 \end{pmatrix}$
<b>B</b>	$\begin{pmatrix} \cos \frac{\pi}{2} \\ \sin \frac{\pi}{2} \end{pmatrix}$	$\begin{pmatrix} 0 \\ 1 \end{pmatrix}$
<b>C</b>	$\begin{pmatrix} \cos \pi \\ \sin \pi \end{pmatrix}$	$\begin{pmatrix} -1 \\ 0 \end{pmatrix}$
<b>D</b>	$\begin{pmatrix} \cos \frac{3}{2}\pi \\ \sin \frac{3}{2}\pi \end{pmatrix}$	$\begin{pmatrix} 0 \\ -1 \end{pmatrix}$

TABLE I

- 1) AC and BD are diameters of the circle.  
Let's check if they bisect each other,

$$\mathbf{A} + \mathbf{C} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} + \begin{pmatrix} -1 \\ 0 \end{pmatrix} \quad (1)$$

$$= \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad (2)$$

$$\mathbf{B} + \mathbf{D} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} + \begin{pmatrix} 0 \\ -1 \end{pmatrix} \quad (3)$$

$$= \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad (4)$$

From equation (2) and (4) AC and BD bisect each other. Hence, we can say that

if two chords bisect each other then they are diameters.

- 2) Let's check if ABCD is a rectangle. The sides of a rectangle are parallel to each other. Let's check if AB and BC are parallel to each other.

$$\mathbf{A} - \mathbf{B} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} - \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad (5)$$

$$= \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad (6)$$

$$\mathbf{D} - \mathbf{C} = \begin{pmatrix} 0 \\ -1 \end{pmatrix} - \begin{pmatrix} -1 \\ 0 \end{pmatrix} \quad (7)$$

$$= \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad (8)$$

From equation (6) and (8), AB and DC are parallel to each other.  $\Rightarrow$  ABCD is a parallelogram.

Now let's check if its a rectangle. Let's check the angle between adjacent sides of this quadrilateral, i.e. AB and BC.

$$\mathbf{A} - \mathbf{B} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} - \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad (9)$$

$$= \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad (10)$$

$$\mathbf{B} - \mathbf{C} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} - \begin{pmatrix} -1 \\ 0 \end{pmatrix} \quad (11)$$

$$= \begin{pmatrix} 1 \\ 1 \end{pmatrix} \quad (12)$$

$$(\mathbf{A} - \mathbf{B})^\top (\mathbf{B} - \mathbf{C}) = \begin{pmatrix} 1 & -1 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \end{pmatrix} \quad (13)$$

$$= 0 \quad (14)$$

From equation (13), we can say that the

angle between  $AB$  and  $BC$  is  $90^\circ$ . Hence, the quadrilateral  $ABCD$  is a rectangle.

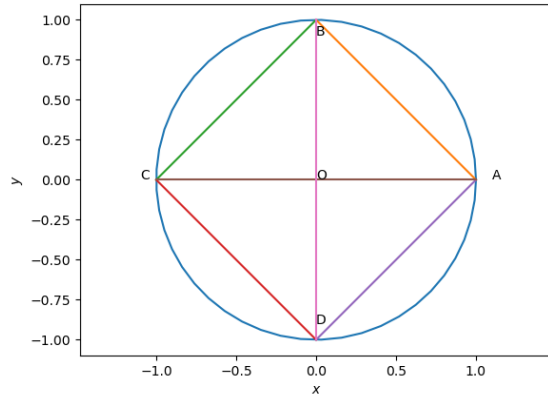


Fig. 1: circle