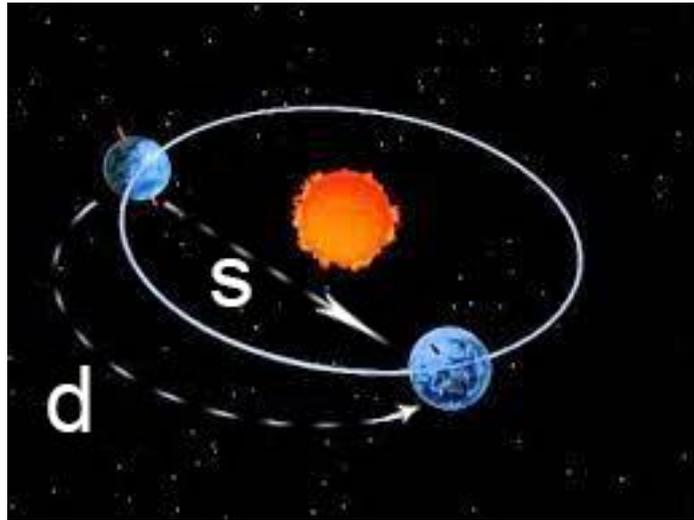


Distance and Displacement

Distance and Displacement, these are the words we use often, but get confused whether they are the same or different. We use the term distance more commonly in our daily lives as we keep travelling to different places. What is it, and how is it different from displacement?



What is Distance?

In simple words, **distance is defined as the amount of space between two points.** It is the length covered while travelling from one point to another. When two objects are placed apart, we say they are separated by a certain distance. **The symbol for distance is d .**

If we consider the motion of an object from a point A to another point B, we say it has travelled a distance from A to B. Point A is the initial or original position and point B is its new position. The change in position from A to B is the distance travelled.

Example:

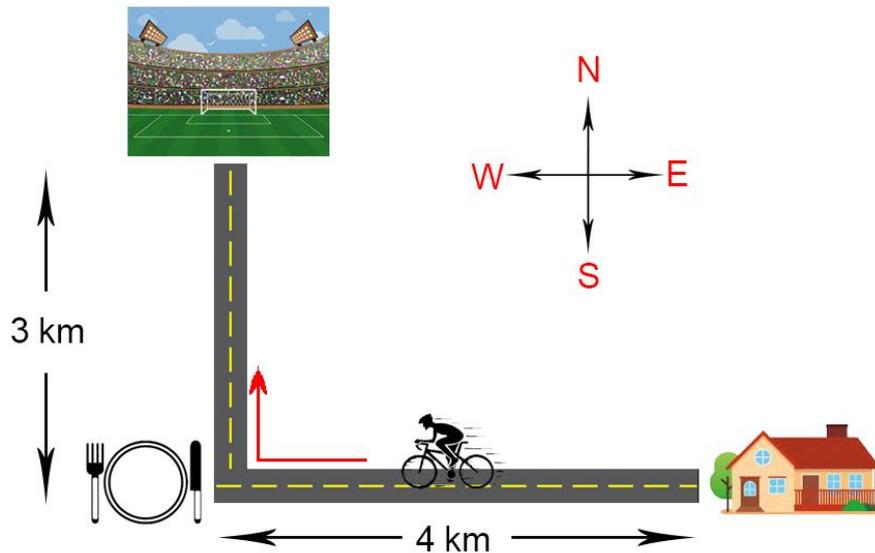
A cyclist leaves his home and travels 4 km towards the west and reaches a hotel. From there, he turns north and travels another 3 km to reach a stadium.

The distance from his home to the hotel, AB is 4 km .

The distance from the hotel to the stadium, BC is 3 km .

The total distance travelled by the cyclist is,

$$\begin{aligned} & AB + BC \\ \Rightarrow & 4 + 3 = 7\text{ km} \end{aligned}$$



What is Displacement?

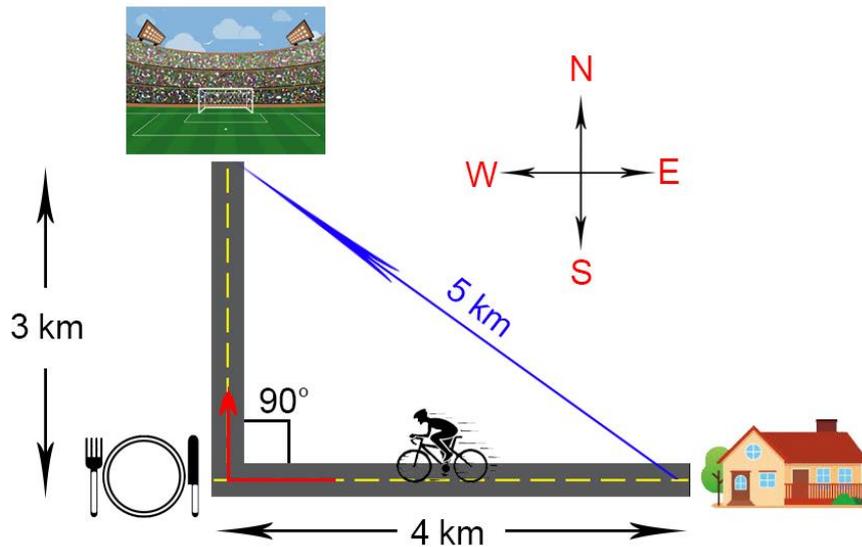
There is a phrase “As the crow flies”. It refers to the straight-line path a bird takes while flying in the sky. Displacement is also a distance but in an exact straight line. **Displacement is the shortest distance between two points.** It refers to the change in position of an object from initial to the final. **The symbol for displacement is S .**

Example:

Taking the same example of the cyclist travelling west and then north, we found the total distance travelled was 7 km . The first path is 4 km and the second is 3 km . We see that he makes a 90° turn after the hotel. The straight-line distance between his home and the stadium is the hypotenuse of a right-angled triangle.

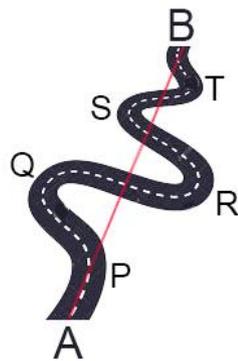
Using Pythagoras theorem,

$$\begin{aligned}
 AB^2 + BC^2 &= AC^2 \\
 4^2 + 3^2 &= 25 \\
 \Rightarrow AC &= 5\text{ km}
 \end{aligned}$$



We see that displacement from his home to the stadium is 5 km in the north-westerly direction.

Distance and Displacement – What is the difference?



$\underline{AP+PQ+QR+RS+ST+TB}$ Distance

$\underline{A \text{---} B}$ Displacement

Distance (d), metres	Displacement (S), metres
It is a scalar quantity, having only magnitude.	It is a vector quantity, having magnitude and direction.
It is the path covered from one point to another point.	It is the straight-line length between point of origin and final position.
It can only increase, but never decrease in magnitude .	It can decrease in magnitude.
It can only be positive .	It can be positive, negative, or zero .
It is the sum of individual paths.	It is always equal to or less than distance.
It can be for straight, bent, or curved paths.	It is always for the straight-line path.

Example: A ball rolls for 5 m on a floor and returns after hitting a wall. It stops after travelling 3 m. What is the distance travelled and the displacement?

Solution:

Distance travelled is the sum of individual paths taken by the ball.

Starting point to the wall: 5 m

Wall to the stopping point: 3 m

Total distance travelled by the ball,

$$5 + 3 = 8 \text{ m}$$

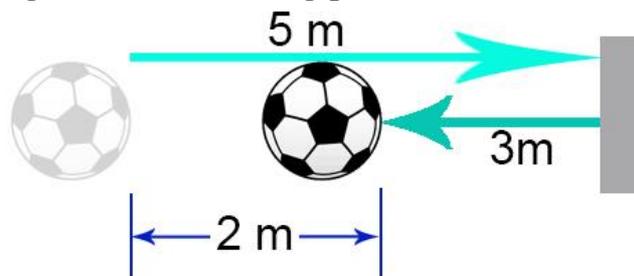
To find displacement, let us consider **right as positive** and **left as negative**.

If the ball rolls **right for 5 m**, then rolls back **3 m in the left direction**,

Displacement is,

$$5 + (-3) = +2 \text{ m}$$

The ball is at 2 m right from its starting point.



When is displacement used?

Displacement is needed in the study of motion of objects, to know the length travelled and the direction of travel.

To give an example, the earth orbits the sun. But the sun too moves in an orbit around the centre of the Milky Way galaxy. So, the position of the earth in one year is not the same but is different as the sun has moved the entire solar system along with it. **The shortest length between this year's position and the previous year's position of the earth is the displacement.**