DISTANCE AND DISPLACEMENT IN ONE DIMENSION

Displacement in Two Dimensions

SCALARS AND VECTORS

A scalar is a variable that only has a magnitude.

A vector is a quantity that has a magnitude and direction.

A vector can be represented using a directed line segment.

ASSIGNING DIRECTION

When using vectors in formula, both magnitude and direction needs to be considered.

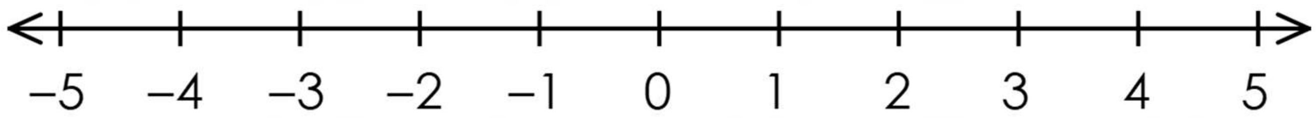
In a one-dimensional problem, one direction from an origin is assigned as "positive" while the opposite direction is "negative".

DISTANCE AND DISPLACEMENT

Distance is a measure of the total path length travelled by an object and is a scalar.

Displacement is the change in position of an object. It is the straight-line distance from the initial position to the final position of an object, considering direction. It is a vector.

$$s = \Delta x = x_f - x_i$$

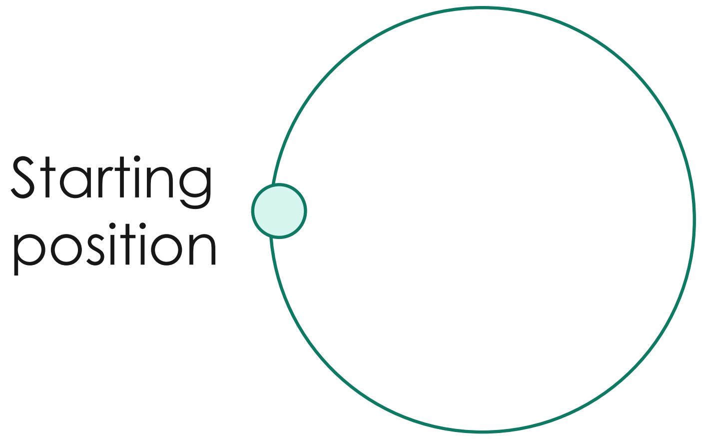


EXAMPLE PROBLEM

A horse, standing at the far west of its round yard, runs halfway around the circular round yard, which has a 9.00 m radius.

a) Determine the distance the horse has moved.

b) Determine the displacement of the horse.

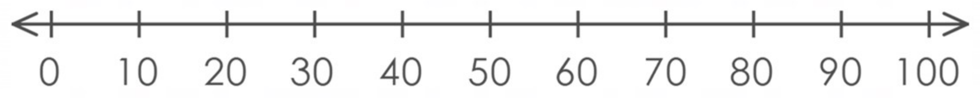


ADDING DISPLACEMENTS

Adding displacements requires addition of vectors. Vectors are added graphically using a “head to tail” method and using positive/negative values mathematically.

Consider a journey where someone walks 70 m east, followed by 50 m west.

Vector Diagram



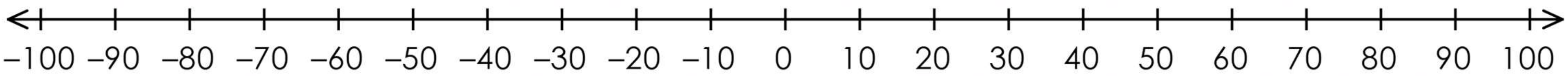
Vector Addition

ORDER OF VECTOR ADDITION DOES NOT MATTER

Vector addition is commutative – it does not matter which order the vectors are added, they produce the same resultant

- Person A walks 70 m east, followed by 50 m west.

- Person B walks 50 m west, followed by 70 m east.



EXAMPLE PROBLEM

Find the distance and displacement of a journey that requires a walk 30.0 m north, followed by 50.0 m south. Draw a vector diagram as part of your answer.

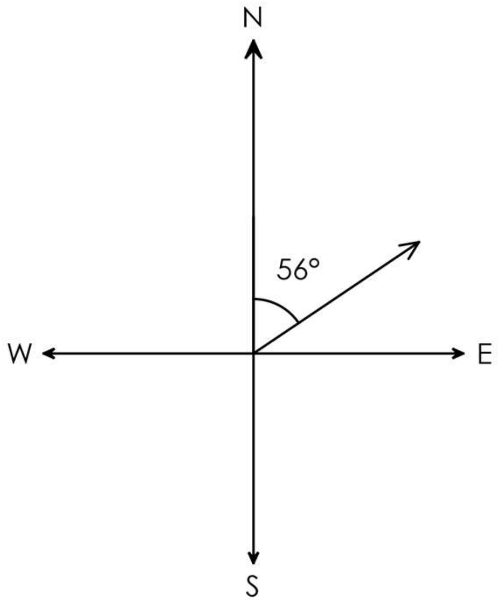
DISPLACEMENT IN TWO DIMENSIONS

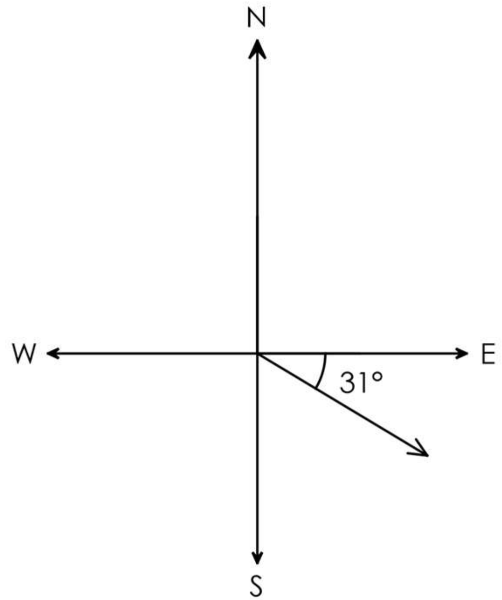
Displacement in Two Dimensions

DIRECTION IN TWO DIMENSIONS

True bearing: Measured clockwise from north

Compass bearing: Measured from closest between north and south, then shortest rotation between east or west



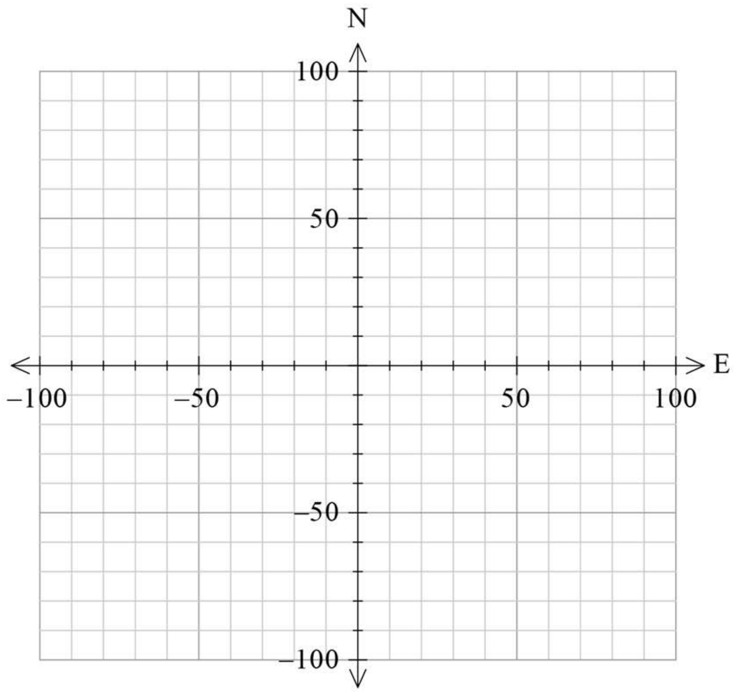


ADDING DISPLACEMENTS IN 2D – GRAPHICAL METHOD

To add displacements in a two-dimensional coordinate system, we can use:

- A vector diagram using "head to tail" addition
- Trigonometry on the resulting vector diagram

Consider a journey where someone walks 70 m north, followed by 50 m east.



EXAMPLE PROBLEM

Vivian walks 2.50 km due north, then proceeds an additional 1.50 km at a bearing of 215^0 T. Determine both the distance and displacement of Vivian's walk.

ADDITION USING COMPONENTS OF VECTORS

Displacement in Two Dimensions

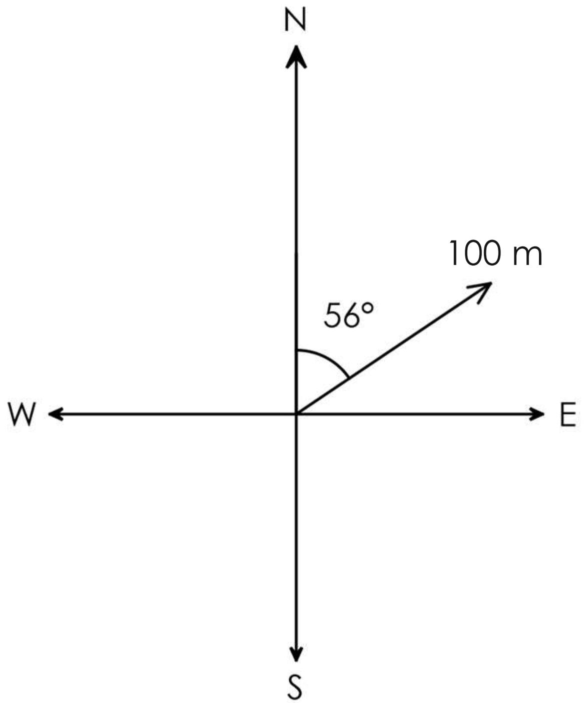
COMPONENTS OF VECTORS

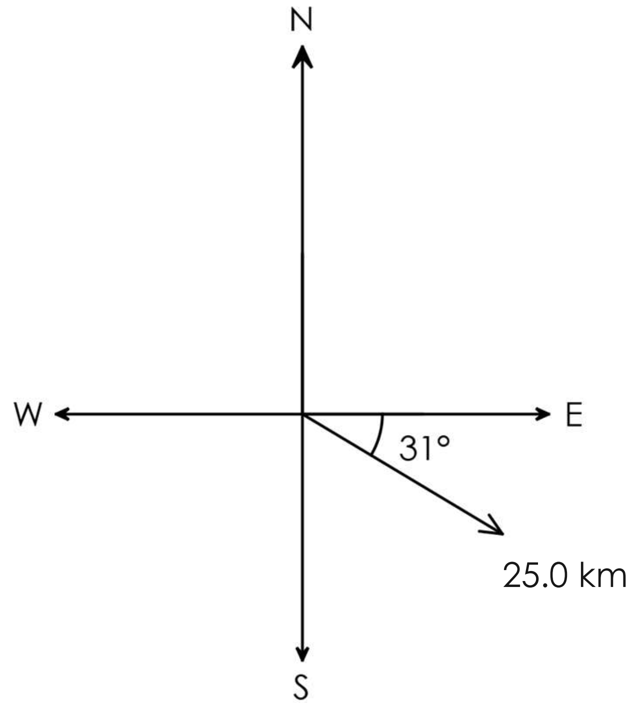
In a two-dimensional coordinate system, a vector can be expressed in terms of its components along the two axes.

To find components (from magnitude and direction), we use trigonometric functions

EXAMPLE PROBLEM

Break each displacement shown below into components along the north/south and east/west axes.

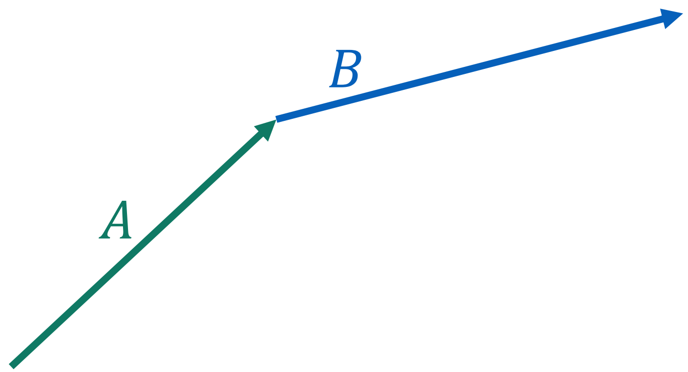




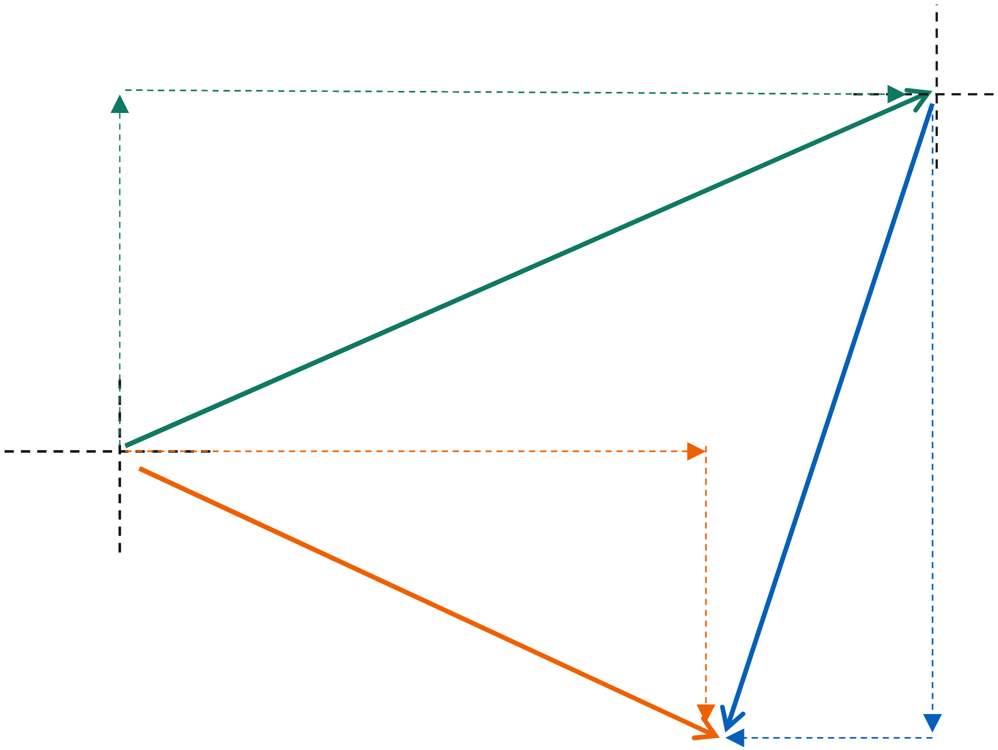
ADDITION OF VECTORS USING COMPONENTS

Recall that addition of vectors is commutative – the order does not matter. When we add two or more vectors:

- The sum of the horizontal components of all vectors gives the horizontal component of the resultant vector.
- The sum of the vertical components of all vectors gives the vertical component of the resultant vector.



ADDITION OF VECTORS USING COMPONENTS



$$R_H = A_H + B_H$$
$$R_V = A_V + B_V$$

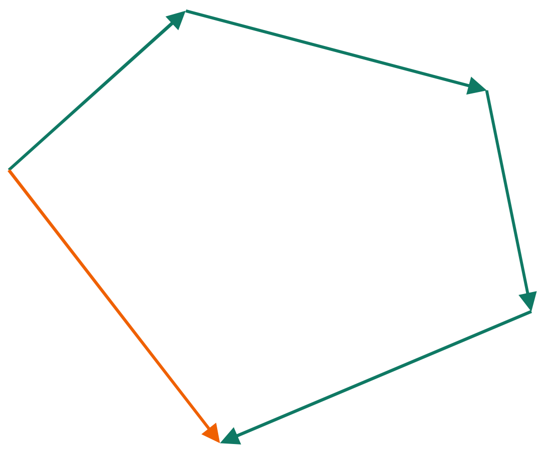
$$R = \sqrt{R_H^2 + R_V^2}$$
$$\theta = \tan^{-1}\left(\frac{R_V}{R_H}\right)$$

EXAMPLE PROBLEM

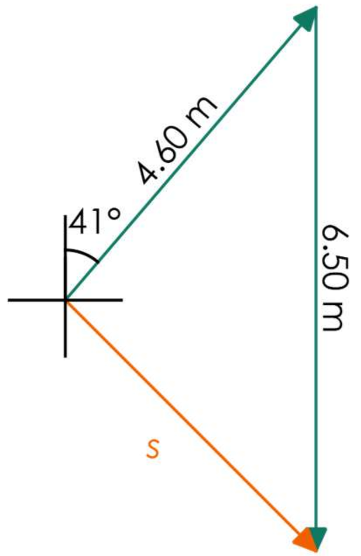
A hiker walks 30.0 km at 060^0 T on day 1, followed by 22.0 km at 115^0 T on day 2. Calculate the displacement of the hiker from the starting position.

BENEFITS OF ADDITION USING COMPONENTS OVER GRAPHICAL METHOD

LESS TIME CONSUMING FOR LARGER PROBLEMS WITH MORE THAN 2 VECTORS BEING ADDED



LESS PRONE TO ERRORS INVOLVING OBTUSE ANGLES



Answer: 4.28 m at 135^0 T