# Vectors and Scalars

N5

## Classifying Vectors and Scalars

Physical quantities can be divided into two groups:

- a **scalar** quantity is completely described by stating its **magnitude** (size) only.
- a **vector** quantity is completely described by stating its **magnitude** and **direction**.

Which quantities are scalars and which are vectors?

| Scalars | Vectors |
|---|---|
| distance | displacement |
| speed | velocity |
| mass | force |
| time | acceleration |
| energy | |

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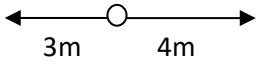
## Vector Diagrams

In order to carry out any calculations we need to know how to calculate the resultant of two vector quantities. This is illustrated in the examples below.

**In a straight line**



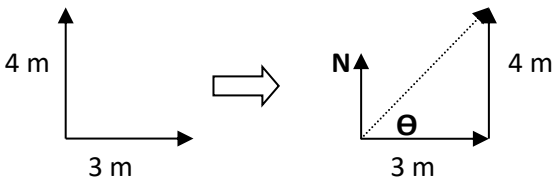


The resultant vector
= 4 – 3 = 1 m (090) or 1 m (due East)

**At right angles**

**Hints**

- **Ensure all vectors are drawn tip to tail**
- **Draw a North line at the start point**
- **Draw the resultant vector from the start to the end point**
- **All bearings are measured clockwise from the North line to the resultant vector.**




Use Pythagoras to calculate the magnitude of the vector

$x^2 = 3^2 + 4^2$

$x = 5m$

Use Tan Θ = opp / adj to find angle Θ

Tan Θ = 4 / 3

Θ = 53.1° bearing = 90 – 53.1 = 36.9

Resultant vector = 5 m (036.9)

# Vector Diagrams and Calculations (ctd)

**N5**

## Distance and Displacement

**Distance** is the total distance travelled regardless of the direction.
**Displacement** is the length measured from the start point to the end point in a straight line. Its direction must be stated.

## Speed and Velocity

As stated previously, speed is defined as the distance travelled per second.
Velocity can be defined as the displacement (s) of an object per second (t) measured in $ms^{-1}$.

Speed and velocity are described by the equations below:

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{velocity} = \frac{\text{displacement}}{\text{time}}$$

In symbol form the velocity equation is:

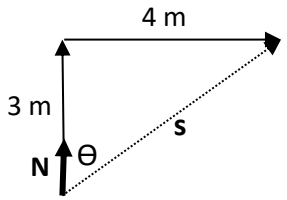
$$\mathbf{v = \frac{s}{t}} \qquad \mathbf{s = v\,t} \qquad \mathbf{t = \frac{s}{v}}$$

| Quantity | Symbol | SI Unit |
|---|---|---|
| velocity | v | m/s or $ms^{-1}$ |
| displacement | s | m |
| time | t | s |

Velocity is a vector quantity and speed is scalar.
The direction of the velocity will be the same as the direction of the displacement.

**Example: A woman walks 3 m due North and then 4 m due East. She takes 10 seconds.**
**a) Find the (i) distance she has walked and (ii) her displacement.**
**b) Calculate her (i) average speed and (ii) velocity.**

**Solution**
We will represent her walk by drawing a vector diagram.




a) (i) The distance she has travelled is 3 + 4 = 7 m
(ii) Her displacement can be calculated using Pythagoras:

$$s^2 = 3^2 + 4^2$$
$$s = 5 \text{ m}$$

The angle Θ is calculated using

$$\text{Tan } \Theta = 4 / 3$$
$$\Theta = 53^o$$

s = 5 m (053)

b) (i) d = 7 m, v = ?, t = 10 s
d= v t
7 = v x 10
v = 0.7 $ms^{-1}$

(ii) s = 5 m, v = ?, t = 10 s
s = vt
5 = v x 10
v = 0.5 $ms^{-1}$ (053)

**Remember that velocity is a vector and requires a bearing = bearing of the displacement.**