## M.2    KINEMATICS

Kinematics is the study of the motion of objects.  This involves a study of position, displacement, velocity, acceleration and time.
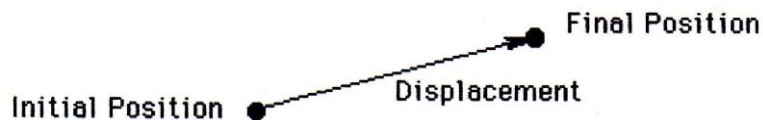
### M.2.1  Position

The position of an object tells us where the object is situated.  The symbol is x and the unit is metres (m).

### M.2.2  Displacement

The displacement of an object is the change in its position and the direction of that change.

Example



Note:  The displacement is independent of how you got there, the distance travelled or the path taken.

Example



The mathematical way of writing "change of" is to use the symbol Δ (delta).

Thus change of position is  $\Delta x = x_f - x_i$

Since displacement has a magnitude and a direction it is a vector

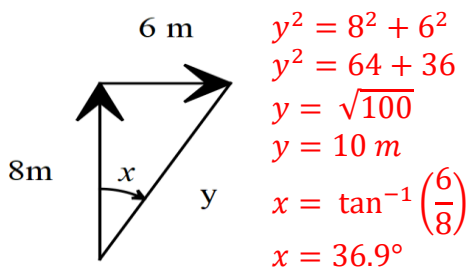Displacement is written as Δx, **x**, $\vec{x}$ or $\vec{d}$.  The unit is metres.

Example

Sue travels 8m in a northerly direction, followed by another 6m in the easterly direction.  What is

a)  Her distance traveled

8 + 6 = 14 m

b)  Her displacement



$$y^2 = 8^2 + 6^2$$
$$y^2 = 64 + 36$$
$$y = \sqrt{100}$$
$$y = 10\,m$$
$$x = \tan^{-1}\left(\frac{6}{8}\right)$$
$$x = 36.9°$$

Displacement is 10 m    N 36.9º E

### M.2.3 Velocity

Velocity is a quantity which tells us how fast an object is travelling and also the direction of travel. Thus velocity is a vector and is denoted by $\vec{v}$ .
The velocity of an object is calculated by using the displacement and the time taken.
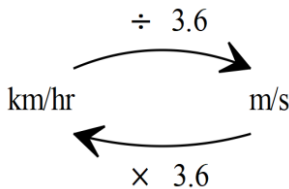
Thus $\qquad \vec{v} = \dfrac{\Delta x}{t} = \dfrac{x_2 - x_1}{t}$

This equation tells us the average velocity over the time Δt.
The units of velocity are metres per second, written as ms$^{-1}$

Velocity should not be confused with speed. Speed is a scalar quantity and is calculated using the following formula

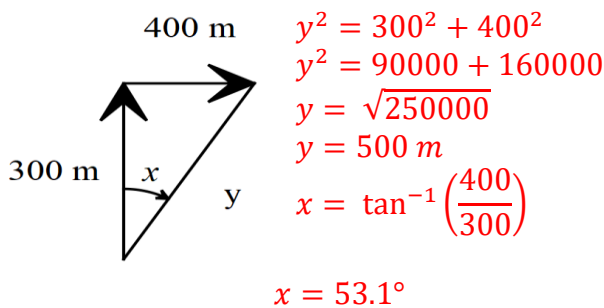$$speed = \dfrac{distance}{time}$$

**Note:**

÷ 3.6

km/hr          m/s

× 3.6

Example
Zoe walks 300m North and then 400m East. If it takes 8 minutes for the journey, find
a. Her average speed

$$speed = \dfrac{distance}{time} = \dfrac{300+400}{8 \times 60} = \dfrac{700}{480} = 1.46 \text{ m/s}$$

b. Her average velocity

$$\vec{v} = \dfrac{displacement}{time}$$

400 m

$y^2 = 300^2 + 400^2$
$y^2 = 90000 + 160000$
$y = \sqrt{250000}$
$y = 500 \; m$

300 m $\quad x$

y

$x = \tan^{-1}\left(\dfrac{400}{300}\right)$

$x = 53.1°$

Displacement is 500 m    N 53.1° E

$$\vec{v} = \dfrac{500}{480} = 1.04 \text{ m/s N 53.1° E}$$

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