Physics: Motion worksheet 1

Vectors and scalars

A scalar is a physical quantity that has magnitude (size) only.

Examples include:

Time

Speed

Mass

Distance

Energy

And there are plenty more

When you give answers for these then you just have to state the size,

For example, the speed is 20m.s^{-1} or the time is 120 seconds

{you would never say 'the time is 20s to the right"}

A vector is a physical quantity that has magnitude (size) and direction.

Eg

Force

Velocity

Acceleration

Displacement

When you give answers for these then you just have to state the size and the direction

For example, the force is 30 N attractive or the velocity is 20m.s^{-1} to the left

Exercise 1: only write the word- vector or scalar next the label

Classify the following as vectors or scalars:

1. length
2. force
3. direction
4. height
5. time
6. speed
7. temperature

Distance and displacement

Distance (Δx)

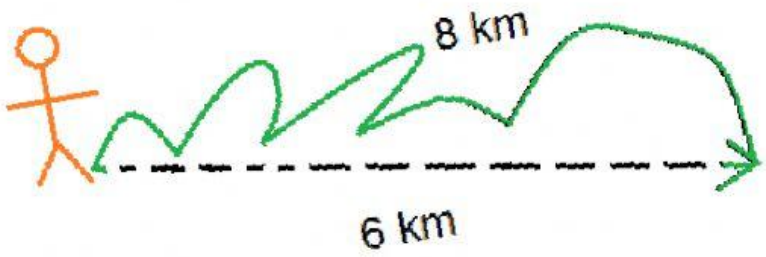
Total path travelled from the initial to the final position.

Displacement ($\vec{\Delta x}$)

This is the shortest distance from the initial to the final position of a point.

Notice that displacement has a little arrow drawn above the symbol, reminding you that you need to give a direction when you write the displacement.

Eg 1



Olwethu starts walking along a bendy (green path) towards the shops.

What is his (a) distance and (b) displacement:

a) Δx = 8000m {remember that meters is the SI unit}

The distance is the actual path distance he travelled and it does **not** need a direction

b) $\vec{\Delta x}$ = 6000m to the right

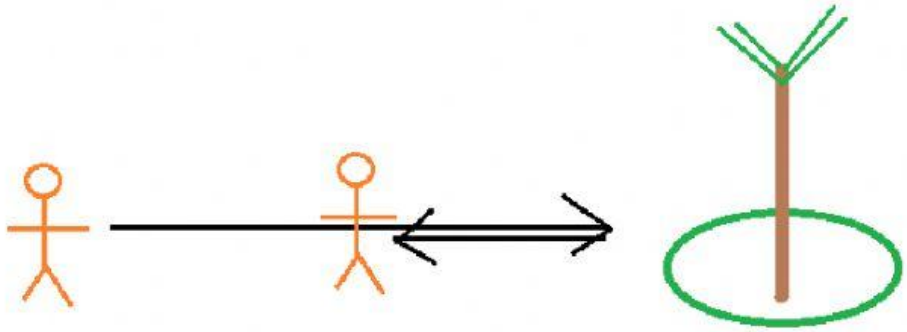
The displacement is the shortest distance from his starting to his end point and needs a direction.

{This is what someone who looked away during the motion will think the person has travelled.}

Eg 2

Alex walks 3000 m to the right towards the park. He then turns around and walks 1000 m to the left

What is his (a) distance and (b) displacement:



a) Δx = 3000 + 1000

= 4000 m {no direction}

b) $\vec{\Delta x}$ = 3000 – 1000

= 2000 m to the right

{Thus the shortest distance from where Alex started to his end point is 2000 m}

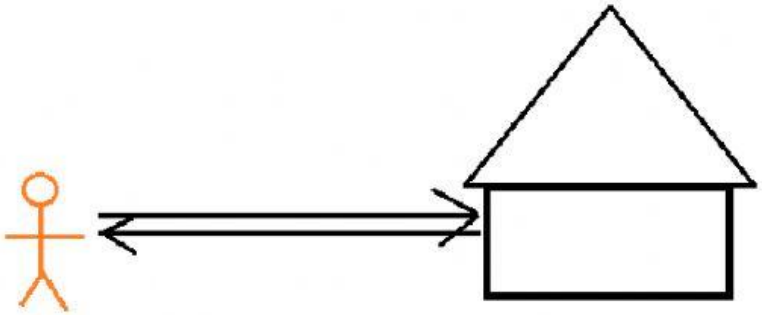
Eg 3

Caitlyn walks 1000 m to the right to get to the shops and then realises she forgot something at home, turns back and walks the 1000 m back to the left

What is her (a) distance and (b) displacement:

a) $\Delta x = 1000 + 1000$

$= 2000\text{m}$



b) $\vec{\Delta x} = 1000 - 1000$

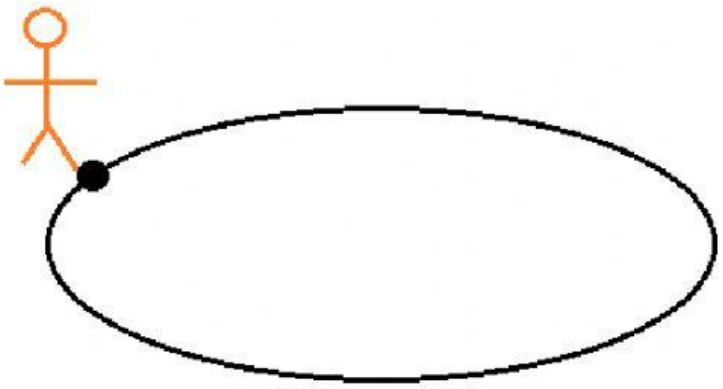
$= 0\text{m}$ {no direction required when the answer is zero}

{Thus to the person who looked away during the motion – it looks like Caitlyn didn't move at all}

Eg 4

Micah runs around a 400 m athletic track and ends back at the starting point

What is her (a) distance and (b) displacement:



a) $\Delta x = 400\text{ m}$

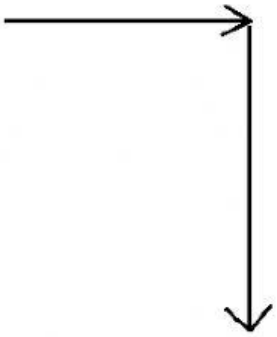
b) $\vec{\Delta x} = 0\text{m}$

Examples not in a straight line

Eg 5

Kyle walks 3m to the east and then 4m south.

What is his (a) distance and (b) displacement:

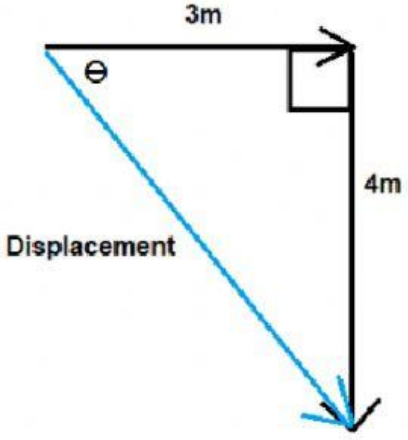


a) the total distance Kyle walked is = 3 + 4

$\Delta x = 7$ m

To determine the displacement:

If we draw a line to connect the starting point to the final position then we get a triangle, and the displacement looks like the hypotenuse of a right angled triangle



Thus we can use Pythagoras to determine the blue side

$\Delta x^2 = \text{side}^2 + \text{side}^2$

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

$\Delta x = \sqrt{25}$

$\Delta x = 5$ m

But displacement needs a direction, thus we can calculate the angle (since it is not just a simple left and right)

You'll need to use trigonometry to do this ☺

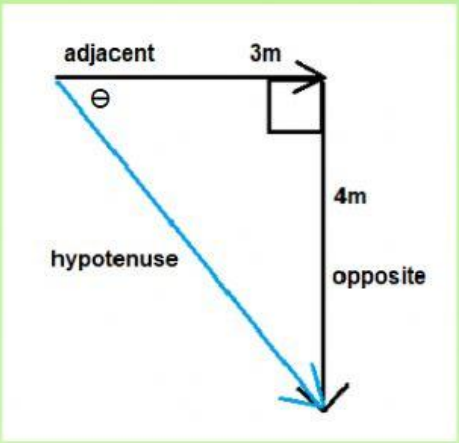
Trigonometry ratios

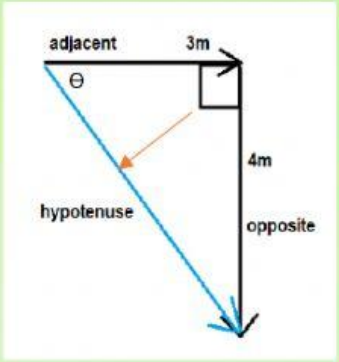
Soh Cah Toa

$\sin \Theta = \frac{o}{h}$

$\cos \Theta = \frac{a}{h}$

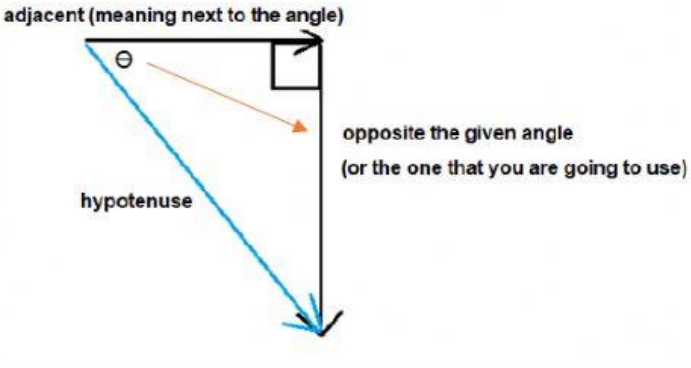
$\tan \Theta = \frac{o}{a}$

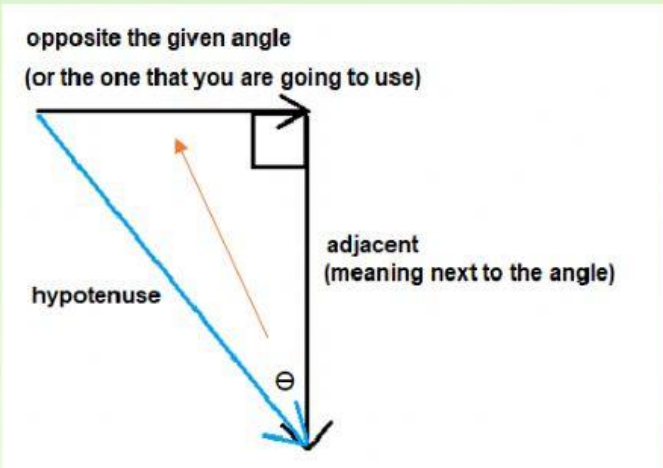




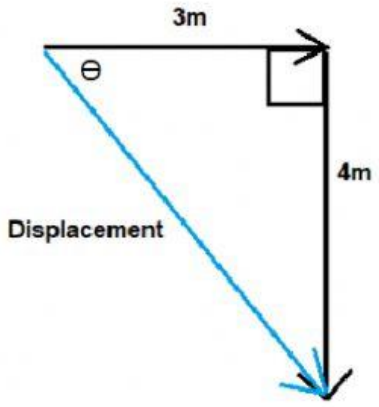
Remember that the hypotenuse is **always** the side opposite the 90° angle.

But the adjacent and opposite sides depends on the perspective of the angle that you are given





Let's calculate the angle of the triangle in example 5



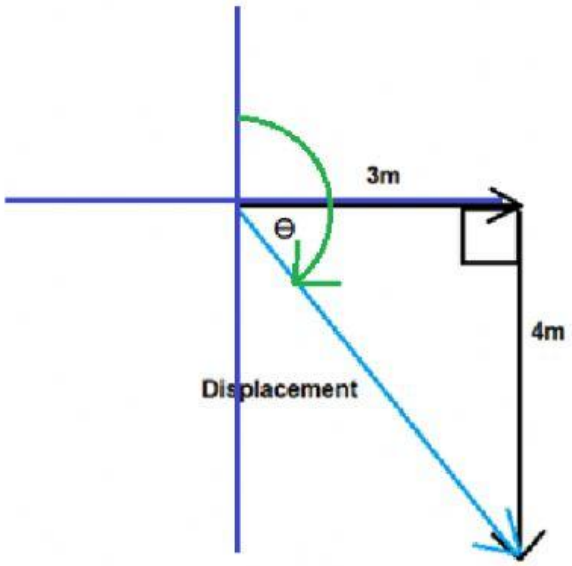
$$\text{Tan } \Theta = \frac{o}{a}$$

$$= \frac{4}{3}$$

$$= 53{,}13\ °$$

This angle needs to be given as a bearing – let's look at what bearing is.

Bearing is an angle that is measured from north, in a clockwise direction until it meets the displacement line



BEARING

Exercise 2

Consider these 16 cardinal points of the compass.

(Remember to move in a clockwise direction only taking N as 0^0.)

e.g. N has a bearing of 0°

1.1 E has a bearing of 90°

1.2 S has a bearing of _____°

1.3 W has a bearing of_____°

1.4 NE has a bearing of 45°

1.5 NW has a bearing of_____°

1.6 SE has a bearing of_____°

1.7 SW has a bearing of_____°

1.8 ENE has a bearing of _____°

1.9 WNW has a bearing of _____°

1.10 ESE has a bearing of_____°

1.11 WSW has a bearing of_____°

1.12 NNE has a bearing of 22,5°

1.13 SSE has a bearing of_____°

1.14 NNW has a bearing of_____°

1.15 SSW has a bearing _____°