

# Scalars and Vectors

## Answer the following questions:

1. State the definition of speed.

**The distance covered per unit time.**

2. State the equation used to calculate speed.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

3. State the SI unit for speed.

**Metres per second (m/s)**

4. State the SI unit for mass and for weight.

**Mass: kg, Weight: N**

5. Explain the difference between mass and weight.

**Mass is the amount of matter in an object and weight is the effect of gravity on that mass.**



# Scalars and Vectors

## P3.1.2

Science  
**Mastery**



P3.1.1 Prior Knowledge Review

➤ **P3.1.2 Scalars and Vectors**

P3.1.3 Resultant Vectors

P3.1.4 Resolving Vectors

P3.1.5 Newton's Third Law

P3.1.6 Newton's First Law

P3.1.7 Acceleration

P3.1.8 Acceleration Investigation

Maths in Science Lesson 17

P3.1.9 Velocity-Time Graphs

P3.1.10 Velocity-Time Graphs 2

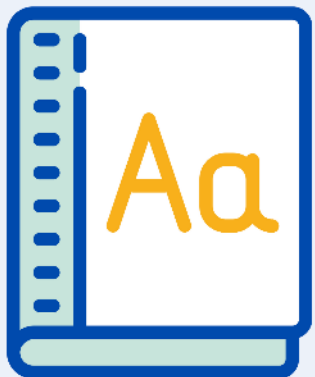
P3.1.11 Acceleration Problems



## Following this lesson, students will be able to:

- Define scalar and vector quantities
- Explain the difference between speed and velocity
- Calculate speed and velocity

## Key Words:



**scalar**

**vector**

**speed**

**velocity**

**distance**

**displacement**

# This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the previous lesson's exit ticket.

- The teacher should customise this slide as needed, to facilitate
  - **reteach, explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.

## Exit ticket

1. Which is the best definition of resultant force?
  - ☐ A. When the forces acting on an object cancel each other out
  - ☐ B. An interaction between two objects
  - ☒ C. The net force acting on an object
2. The speed of a car that travels 100 metres in 5 seconds is...
  - ☒ A. 20 m/s
  - ☐ B. 0.05 m/s
  - ☐ C. 500 m/s
3. A horizontal line on a distance-time graph represents...
  - ☐ A. An object moving at constant speed
  - ☐ B. An object accelerating
  - ☒ C. A stationary object

## General Definition

Noun: An organism that transmits a disease or parasite from one plant or animal to another.

From the Latin *vehere* meaning 'to carry'.

## Scientific Definition

A physical quantity that has both magnitude and direction.

# Vector

**'Happiness is not a state of being. Happiness is a vector, it is movement.'**

**Neal Shusterman**

## Synonyms

Transmitter  
Carrier

## General Examples

Mosquitos are a vector of malaria.

## Scientific Examples

Force is a vector because it has both magnitude and direction.



# Scalars and Vectors

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

Examples of scalar quantities are distance, speed and energy.

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

Examples of vector quantities are displacement, velocity, acceleration and force.



# Speed and Velocity

**Speed** is the distance covered per unit time.

**Distance** is the length of the path between two points.

$$\textit{Speed} = \frac{\textit{Distance}}{\textit{Time}}$$

**Velocity** is speed in a given **direction**.

$$\textit{Velocity} = \frac{\textit{Displacement}}{\textit{Time}}$$

**Displacement** is how far an object is from its original **position** or a point of reference in a given **direction**.

Word:

# Displacement



Comes  
from:

*Dis-*

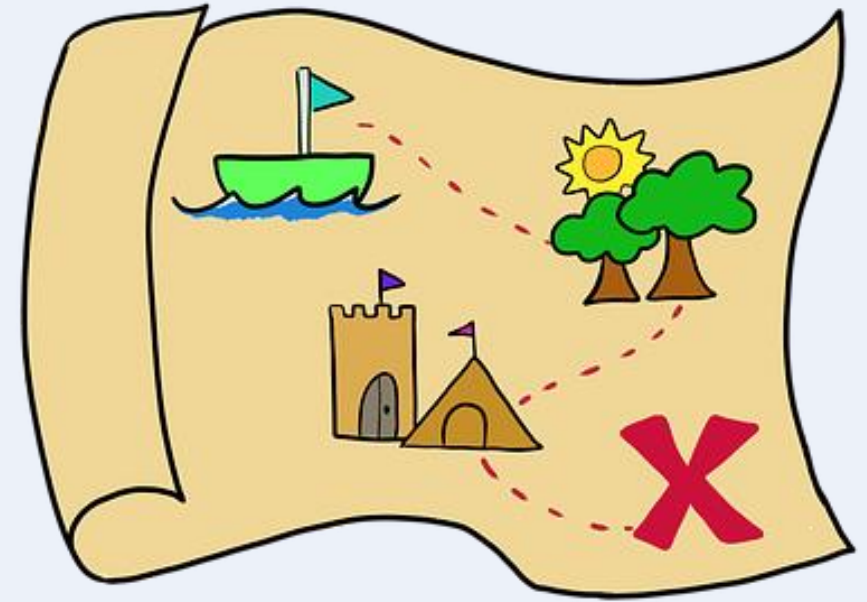
*-place-*

*'apart' or 'remove'*

*'location'*

Definition:

How far an object is from its original position or a point of reference in a given **direction**.





# I: Calculating Speed and Velocity

A hiker walks 2000 metres North before realising they have followed the wrong path. They then walk 4000 metres South. The whole journey took 2000 seconds.

**What is the distance covered by the hiker?**

$$2000 \text{ m} + 4000 \text{ m} = 6000 \text{ m}$$

**What is the average speed of the hiker?**

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Speed} = \frac{6000 \text{ m}}{2000 \text{ s}}$$

$$\text{Speed} = 3 \text{ m/s}$$

# We: Calculating Speed and Velocity

A hiker walks 2000 metres North before realising they have followed the wrong path. They then walk 4000 metres South. The whole journey took 2000 seconds.

**What is the displacement of the hiker?**

2000 m South

**What is the velocity of the hiker?**

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

$$\text{Velocity} = \frac{2000 \text{ m South}}{2000 \text{ s}}$$

$$\text{Velocity} = 1 \text{ m/s South}$$





## You: Calculating Speed and Velocity

A runner runs 400 metres West then 800 m South. Then they run West again for 1200 m, before finishing with 800 m North. The whole run took 800 seconds.

**What is the distance covered by the runner?**

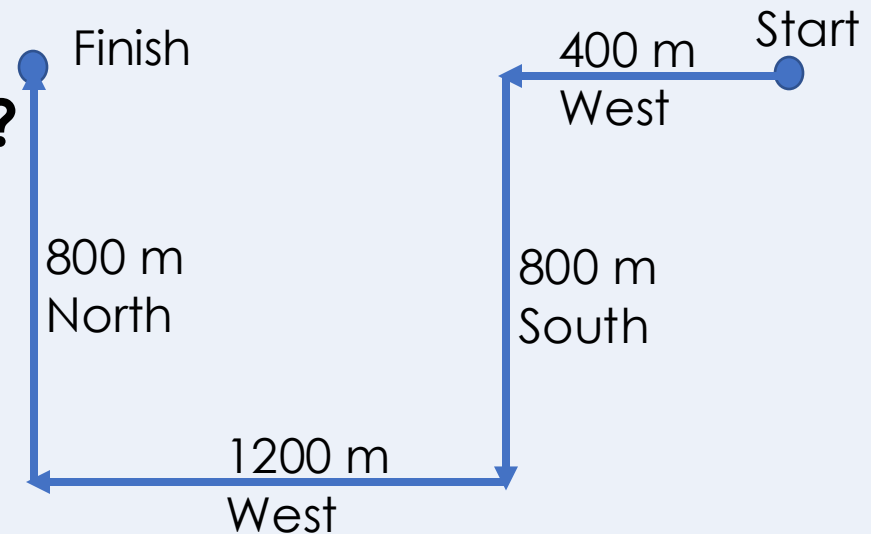
$$400 + 800 + 1200 + 800 = 3200 \text{ m}$$

**What is the average speed of the runner?**

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Speed} = \frac{3200 \text{ m}}{800 \text{ s}}$$

$$\text{Speed} = 4 \text{ m/s}$$



# You: Calculating Speed and Velocity

A runner runs 400 metres West then 800 m South. Then they run West again for 1200 m, before finishing with 800 m North. The whole run took 800 seconds.

**What is the displacement of the runner?**

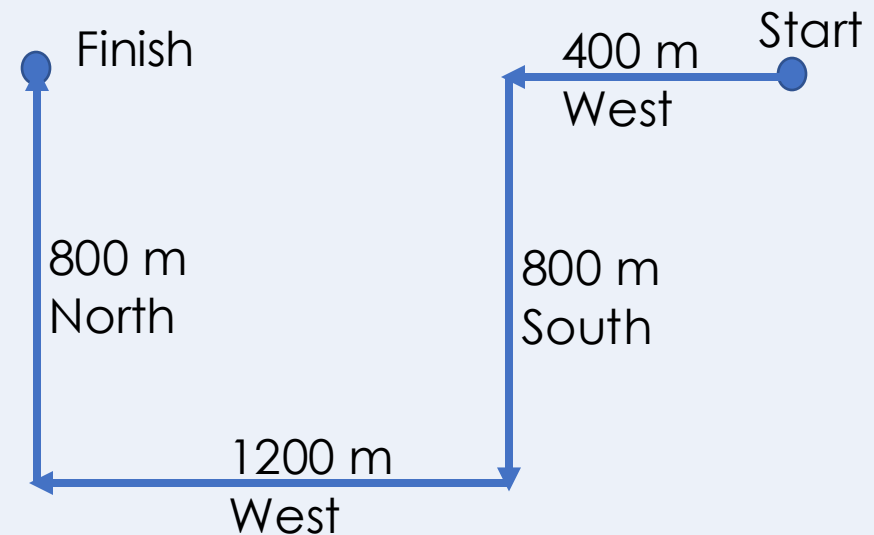
1600 m West

**What is the average velocity of the runner?**

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

$$\text{Velocity} = \frac{1600 \text{ m}}{800 \text{ s}}$$

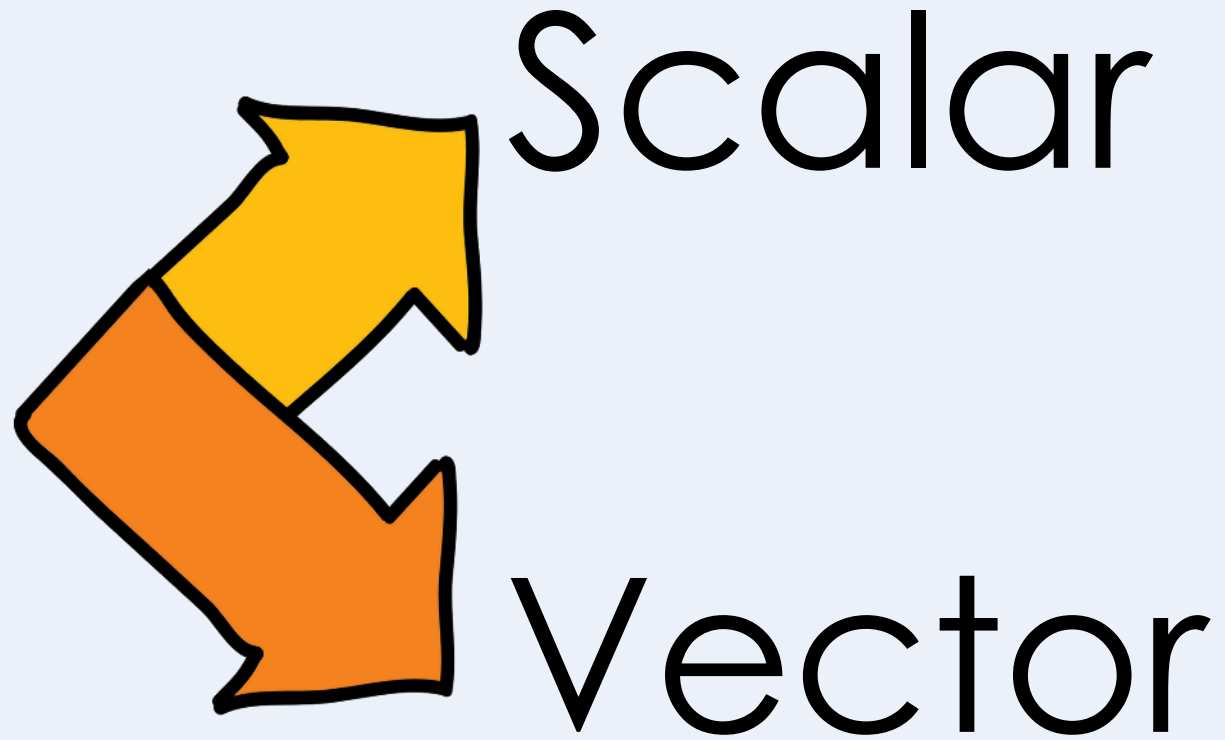
$$\text{Velocity} = 2 \text{ m/s West}$$



## Quick Quiz:

1. What is a scalar quantity?  
**A quantity that has magnitude/size only.**
2. What is a vector quantity?  
**A quantity that has magnitude/size and direction.**
3. Give an example of a scalar quantity.  
**Distance, speed, mass, energy**
4. Give an example of a vector quantity.  
**Displacement, velocity, acceleration, force, weight**
5. How can speed be calculated? **Speed =  $\frac{\text{Distance}}{\text{Time}}$**
6. How can velocity be calculated? **Velocity =  $\frac{\text{Displacement}}{\text{Time}}$**

Can you explain the difference between these two words?



*What is the definition of each?*

*Which has a magnitude  
(size)?*

*Which has a direction?*

*Can you give an example of  
each?*

*Can you explain why your  
example is a scalar or vector?*

## Which statements do you agree with?

I think that mass and weight are both scalars because they do not have directions.

I think that mass is scalar because it does not have a direction.

I think that weight is a vector because it is a force.

I think that mass and weight are both vectors because they both act downwards.

# Drill

1. What is a scalar quantity?
2. What is a vector quantity?
3. What is the difference between speed and velocity?
4. What is displacement?
5. You travel in a circle for one kilometre, you then rest for two minutes and then travel three more kilometres. You reach the start of the circle. What was the distance travelled in this circle?
6. You travel in a circle for one kilometre, you then rest for two minutes and then travel three more kilometres. You reach the start of the circle. What was the displacement travelled in this circle?
7. What equation is used to calculate speed?
8. What equation is used to calculate velocity?
9. What is your velocity if you travel due east for 100m and 10s?



## Drill answers

1. A scalar quantity only has magnitude/size
2. A vector quantity has magnitude/size and direction
3. Speed is a scalar quantity whereas velocity is a vector quantity
4. Displacement is how far an object travels from its original position two point of reference in a given direction
5.  $1 + 3 = 4$  km
6. 0 km as you travelled back to the original position in the circle
7.  $\text{Speed} = \frac{\text{distance}}{\text{Time}}$
8.  $\text{Velocity} = \frac{\text{displacement}}{\text{Time}}$
9.  $\text{Velocity} = \frac{100 \text{ m}}{10\text{s}} = 10\text{m/s}$

# ***Explain: to use scientific understanding to make something clear or state the reason for something happening***

Example question:

This is the biggest bus route in Europe at a distance of 26 miles.

**Explain** how this route has a displacement of zero.



To 'explain' your answer should:

- Begin with a **scientific statement**.
- Use 'this means that', 'because' or 'so' **to link your statement to the question**.

Model answer:

- Displacement is how far an object travels from its original position to a point of reference in a given direction.
- Displacement will be zero if you start in Northfield, move clockwise and finish in Northfield. This is because you have travelled in a particular direction **and** you have travelled from the original position back to the original position.



## Answer the questions below.

1. Velocity is a vector quantity because...

- ☒ A. It has magnitude/size and direction
- ☐ B. It has magnitude/size only
- ☐ C. It is how much distance is covered in a given time

2. If a person walks 4 m left then 8 m right...

- ☐ A. Their displacement is 12 m right
- ☒ B. Their displacement is 4 m right
- ☐ C. Their displacement is 4 m left

3. What would the velocity of the person in Q2 be if they completed these movements in 8 seconds?

- ☐ A. 1.5 m/s right
- ☐ B. 0.5 m/s
- ☒ C. 0.5 m/s right

## Lesson P3.1.2

What was good about this lesson?

What can we do to improve this lesson?

[Send us your feedback by clicking this link](#)  
or by emailing [sciencemastery@arkonline.org](mailto:sciencemastery@arkonline.org)  
Thank you!