Speed and Velocity Walkthrough Worksheet **Answers**

1. Identify the difference between speed and velocity.

   Speed is the rate at which an object travels a distance. It is a scalar measurement which is a measure of size only and not direction. Velocity is a vector quantity that measures the rate at which an object changes position. Size and direction are indicated.

2. On a weekday, you walk 150m from home to school and then back home again at the end of the day.

   a. Calculate the total distance travelled in one school week (Monday-Friday).

      Distance travelled in one day:

      150 + 150 = 300m

      Distance travelled in one week:

      300 x 5 = 1500m

   b. If it takes you 5min to walk to school, what is your average speed? Give your answer in m/s (metres per second).

      $$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

      5 minutes in seconds = 5 x 60 = 300s

      $$Average\ Speed = \frac{150m}{300s}$$

      $$= 0.5m/s$$

      Your average walking speed is 0.5m/s.

3. Complete the following calculations for the two trains below.

   a. Calculate the average speed of a train that has travelled 500km in 5 hours. Give your answer in km/hr.

      $$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

      $$Average\ Speed = \frac{500km}{5hr}$$

      $$= 100km/hr$$

      The average speed of the train is 100km/hr.

   b. Calculate the distance travelled by a train in 3.5 hours that is travelling at a speed of 70km/hr.

      $$Distance\ travelled = Average\ Speed \times Time$$

      245km = 70km/hr × 3.5hr

      In 3.5hr the train travelled a distance of 245km.

4. Describe what is wrong with the statement: I am driving at a velocity of 100km/hr.

   Velocity is a vector quantity that measures the size and direction of movement. No direction is given above.

5. A beetle travels southwest across a 2m driveway in 6.5min. What is the average velocity of the beetle in m/s?

   $$\textit{Average Velocity} = \frac{\textit{Distance travelled}}{\textit{Time taken}}$$

   6.5min x 60s = 390s

   $$\textit{Average Velocity} = \frac{2\text{m}}{390\text{s}}$$

   = 5.1×10^{-3}m/s OR 0.0051m/s southwest

6. Calculate the average velocity (in m/s) of a cyclist that starts 152m north of town and after 30min is 5107m north of town.

   Displacement (change in position) = final position - initial position

   5107m north - 152m north = 4955m north

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

   30 × 60 = 1800s

   $$\textit{Average Velocity} = \frac{4955\text{m}}{1800\text{s}}$$

   = 2.75m/s north

7. The school cross-country race is coming up and involves running a circuit (start and finish are in the same place), that spans a distance of 4000m. To prepare for the school cross-country, you must spend many hours training to have a competitive edge. Even though you practise for a few hours each week, your average velocity during the practice is 0m/s. Explain how this is possible.

   This is possible because during a cross-country race, the start and finish positions are in the same place. This means that your displacement is 0 because your final and initial positions are the same. Velocity is calculated by dividing the displacement by time. As the displacement is 0, the answer will always end up 0m/s.

8. Malakai and Josef walk from Point A to Point C.

   Malakai walks the following route, A → B → C. While Josef walks from A → C directly. Both boys arrive exactly 30 seconds after leaving Point A.

   a. Calculate the average speed of each boy and determine who was travelling faster.

      Average speed for Malakai:

      Distance travelled = 4 + 4 = 8m

$$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

$$Average\ Speed = \frac{8m}{30s}$$

= 0.27m/s

Average speed for Josef:

$$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

$$Average\ Speed = \frac{5.7m}{30s}$$

= 0.19m/s

Malakai is travelling faster at a speed of 0.27m/s while Josef is only travelling at a speed of 0.19m/s.

b. Calculate the velocity for Malakai and Josef. Explain why their speed is different but their velocity is the same.

Average velocity for Malakai and Josef:

Displacement (change in position) = final position - initial position

5.7m - 0 = 5.7m southeast

$$Average\ Velocity = \frac{Displacement}{Time\ taken}$$

$$Average\ Velocity = \frac{5.7m}{30s}$$

= 0.19m/s southeast

Speed is measured by calculating the total distance travelled over the time taken. Velocity is measured by calculating the displacement over time. This means that even though Malakai travelled a further distance, his displacement is the same as Josef's. He travelled at a faster speed, but the rate at which he changed position is the same.

Speed and Velocity **Walkthrough Worksheet**

What is speed?

You would already have a sense of what speed is when you think about one object moving faster or slower than another.

But how do we know which object is faster?

Consider two cars travelling a distance of 20km.

The first car travelled 20km in 20min.

The second car travelled 20km in 30min.

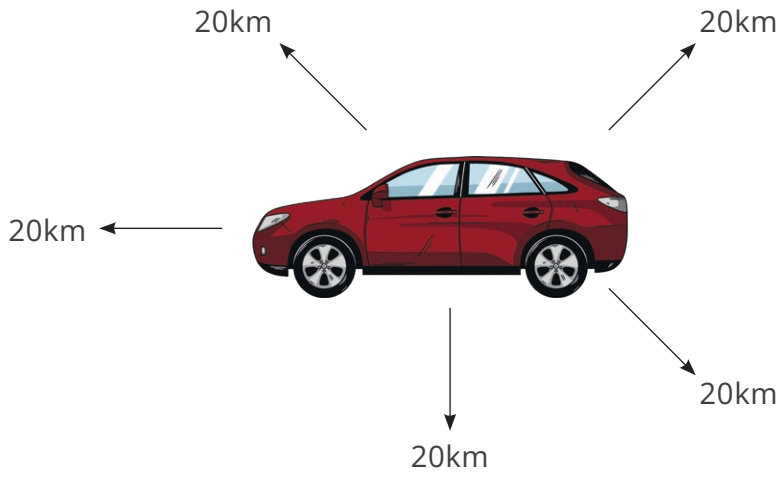
Which car was travelling faster? The first car.

How did you know?

The answer lies in your understanding that speed is a measure of distance travelled over the time taken to get there.

$$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

This information doesn't tell you anything about the direction in which the cars were travelling.

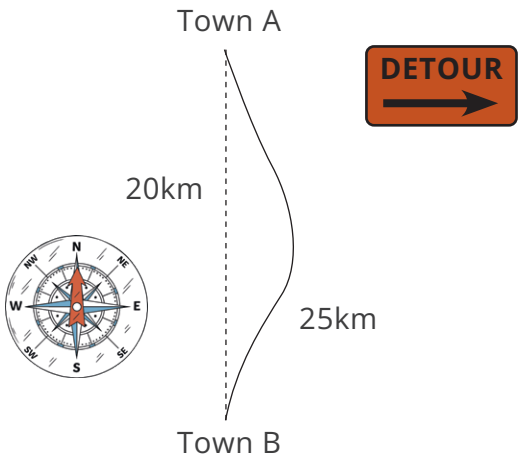


Speed and Velocity

Imagine you are travelling from Town A to Town B.

Ordinarily, you would drive the shortest distance to your destination. However, today you come across roadworks and there is an option of a detour.

Your journey would now look like this.



However, the time taken to make this journey was still 30min, irrespective of the route taken. This means that when travelling the detour route, you were travelling at a faster speed than when you are on your regular route.

If we were to calculate average speed we would use the distance travelled divided by the time taken.

$$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

$$Average\ Speed = \frac{25\text{km}}{0.5\text{hours}}$$

$$= 12.5\text{km/hr}$$

However, if we were to calculate average velocity, we would use displacement over the time taken.

$$Average\ Velocity = \frac{Displacement}{Time\ taken}$$

$$Average\ Velocity = \frac{20\text{km}}{0.5\text{hours}}$$

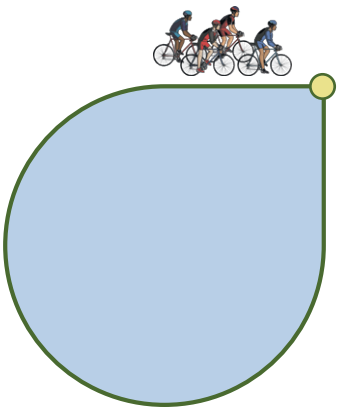
$$= 10\text{km/hr south}$$

Speed is the rate at which an object travels a distance. It is a scalar quantity.

Velocity is the rate at which an object changes position. It is a vector quantity.

Example 1:

You are completing a cycling race that follows a path along a lake as in the image below.



It takes you 4hr 30min to complete the 90km loop.

a. What is your average speed?

$$Average\ Speed = \frac{Distance\ travelled}{Time\ taken}$$

$$Average\ Speed = \frac{90km}{4.5hours}$$

$$= 20km/hr$$

b. What is the average velocity?

The starting and final positions are the same. This results in a displacement value of 0.

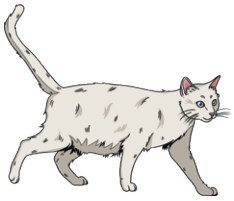
$$Average\ Velocity = \frac{Distance\ travelled}{Time\ taken}$$

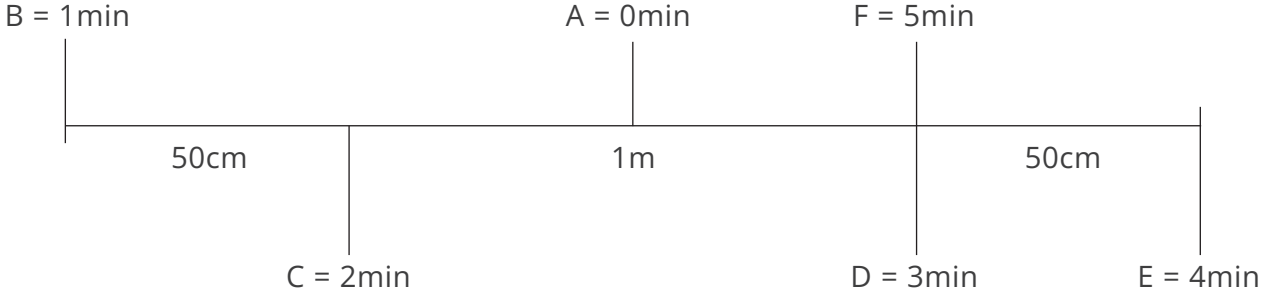
$$Average\ Velocity = \frac{0km}{4.5hours}$$

$$= 0$$

Example 2:

My cat is pacing at the sliding door. I observed her movements for five minutes and recorded the results below.





a. Calculate the average speed of the cat during these 5min. Give your answer in m/s.

1min A → B = 1m

2min B → C = 0.5m

3min C → D = 1m

4min D → E = 0.5m

5min E → F = 0.5m

1 + 0.5 + 1 + 0.5 + 0.5 = 3.5m

5 x 60 = 300s

Use the formula for calculating speed:

$$Average\ Speed = \frac{3.5m}{300s}$$

$$= 0.01m/s$$

We can determine that the cat moved at a speed of 0.01m/s.

b. Calculate the average velocity of the cat during these 5min.

Displacement (change in position) = final position - initial position

0.5 − 0 = 0.5m

This results in an overall movement of 0.5m to the right.

Use the formula for calculating velocity:

$$Average\ Velocity = \frac{0.5km}{300s}$$

$$= 0.002m/s$$

We can determine that the cat moved at an average velocity of 0.002m/s to the right.

Motion Questions:

Make sure to show all of your working out.

1. Identify the difference between speed and velocity.

2. On a weekday, you walk 150m from home to school and then back home again at the end of the day.
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   b. If it takes you 5min to walk to school, what is your average speed? Give your answer in m/s (metres per second).

3. Complete the following calculations for the two trains below.
   a. Calculate the average speed of a train that has travelled 500km in 5 hours. Give your answer in km/hr.

   Calculate the distance travelled by a train in 3.5 hours that is travelling at a speed of 70km/hr.

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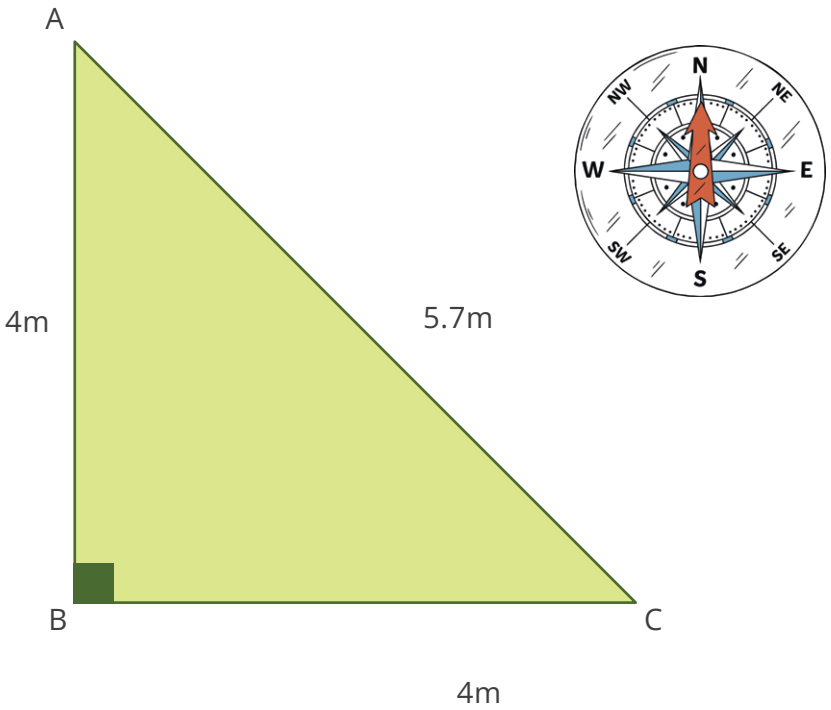

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