Calculating speed

To calculate the speed of a moving object, you divide the distance it travels by the time it takes to travel that distance. Average speed is the total distance divided by the total time taken, but instantaneous speed tells you how fast something is moving at a particular moment.

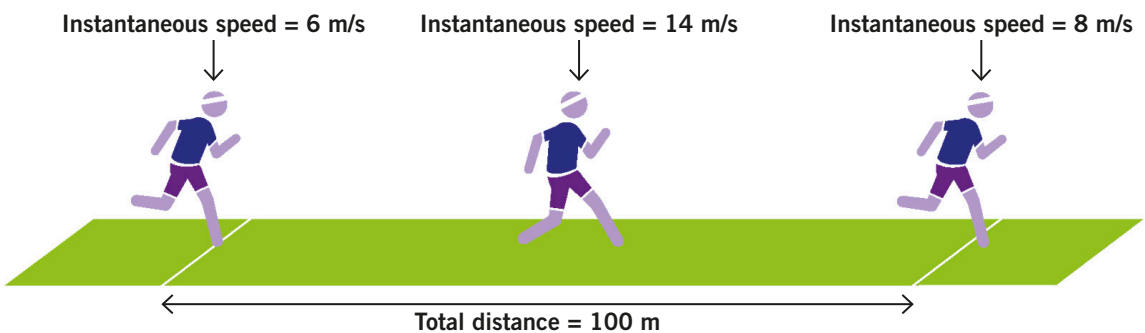
Key facts

- ✓ **Average speed is equal to the total distance traveled divided by the total time taken.**
- ✓ **Instantaneous speed is how quickly something is moving at a specific point in time.**

Average and instantaneous speed

Imagine a sprinter running a 100 m race. At the very start, she moves slowly, but she soon speeds up. Toward the end, she might get tired and slow down a little. Her instantaneous speed has changed throughout the race, but we can calculate her average speed using the formula below.

$$\text{average speed (m/s)} = \frac{\text{total distance (m)}}{\text{total time (s)}}$$



Calculating speed

Question

A sprinter completes a 100 m race in 12.5 seconds. What is her average speed?

Answer

Average speed = $\frac{\text{total distance}}{\text{total time}}$

= $\frac{100\text{ m}}{12.5\text{ s}}$

= 8 m/s

Calculating distance

Question

A cyclist in a race rides for 25 seconds with an average speed of 12 m/s. How far does he cycle?

Answer

Rearrange the equation to work out distance rather than speed:

Total distance = average speed × total time

= 12 m/s × 25 s

= 300 m

Measuring speed

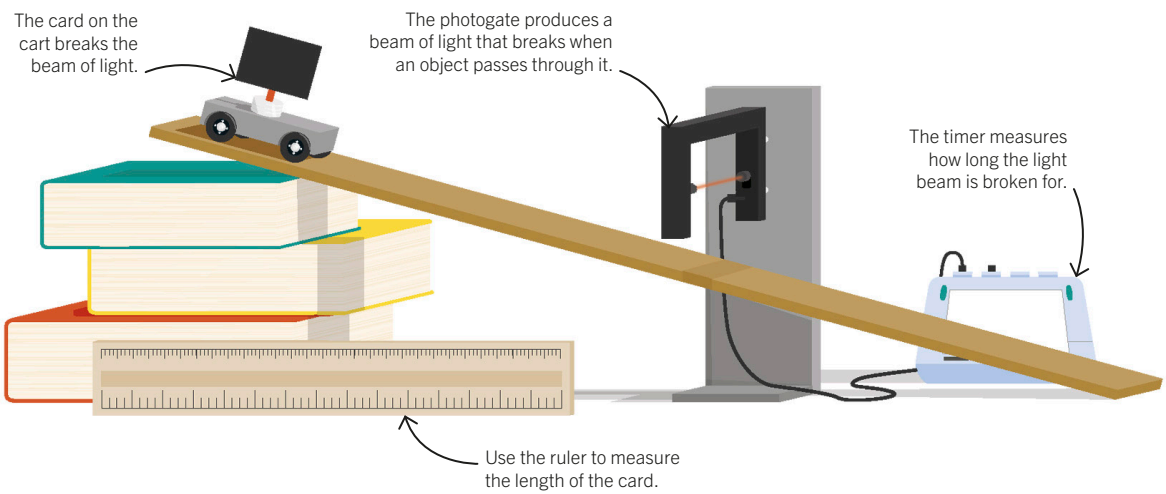
To measure speed, you have to measure the distance an object travels and the time it takes to travel that distance. Instruments used to measure distance include rulers and tape measures. Instruments used to measure time include stopwatches and photogates.

Key facts

- ✓ **Instruments used to measure distance include rulers and tape measures.**
- ✓ **Instruments used to measure time include stopwatches and photogates.**
- ✓ **Photogates use a beam of light to measure time very accurately.**

Photogates

A photogate is used to calculate the speed of fast-moving objects. It measures very brief time intervals much more accurately than a person can do with a stopwatch. In the experiment shown here, a cart carrying a card breaks the light beam for a fraction of a second. To find the cart's speed at that point, divide the length of the card by the time interval recorded.



Speed guns

The radar speed guns used by police to check if drivers are speeding use radio waves. When the outgoing radio waves reflect off an approaching car, their frequency and wavelength change. The faster the car, the higher the frequency of the reflected waves. The speed gun detects the returning echoes and uses their frequency to calculate the car's speed.