GZ Science Resources

The different types of motion

Objects that move from one point of space to another over time are said to have **motion**. Examples include a tortoise slowly moving across the ground or a bullet moving fast after it has been fired from a gun. Objects that remain at the same point of space over time are called **stationary**. Examples include a person sitting still on a chair or a parked car.

Measuring Motion in Science

Quantity	Unit	Symbol	Equipment used
Distance	Kilometre	km	odometer
	Metre	m	Metre ruler
	millimetre	mm	Hand ruler
Time	Hour	hr	clock
	minute	min	watch
	second	s	Stop watch

Converting measurements

Quantities are often measured in different **scales** depending upon what is most appropriate for the original size. In Science (and Mathematics) we use common **prefixes** to indicate the scale used.

We sometimes want to convert scales from one to another to compare data or to place the measurements into equations.

To convert from metres to kilometres **divide** by 1000

To convert from kilometres to metres **multiply** by 1000

Time is measured in "imperial units" 1 hour has 60 minutes and 1 minute has 60 seconds **therefore** 1 hour has 3600 seconds

Prefix		Scale
Kilo	=	1000
Centi	=	1/100th
Milli	=	1/1000th

So 1 kilometre = 1000 metres
1 metre contains 100 centimetres
1 metre contains 1000 millimetres

NOTE: to convert speed

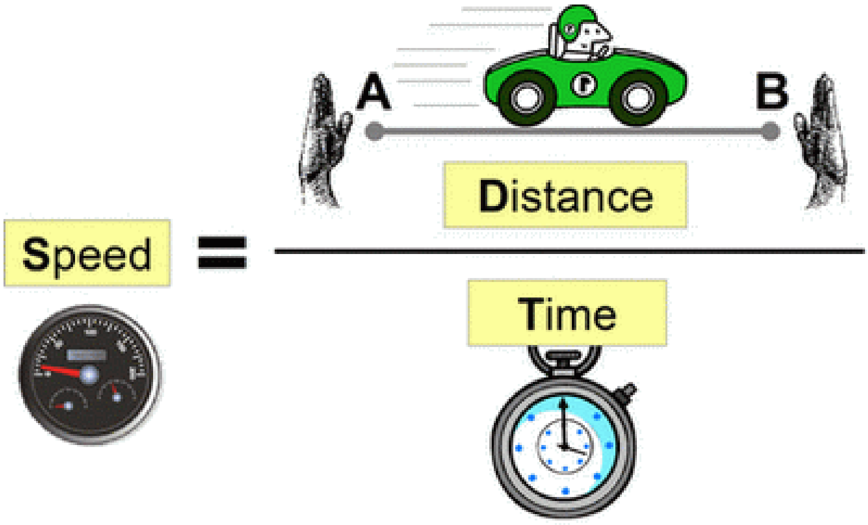
ms^{-1} to $kmhr^{-1}$ multiply by 3.6

$kmhr^{-1}$ to ms^{-1} divide by 3.6

Speed

Speed is a measure of the distance travelled over the time taken. The more distance covered by an object during a given time, the faster the speed it is moving. In this unit we use the term **velocity** to mean the same thing.

Constant speed occurs when the object travels the same amount of distance at each even time period. When we travel on an object moving at a constant speed, we do not feel movement for example travelling in an airplane. Only when we observe other objects moving at a different speed to us do we notice that we are moving.



Calculating speed

We use this **formula** to calculate speed by placing in the information we have about distance /time into it. We can also rearrange the formula to calculate distance or time, if we know the other two values. It is important to also use the units after any value in Science.

$$v=d/t$$

v = velocity (ms^{-1})
d = distance (m)
t = time (s)

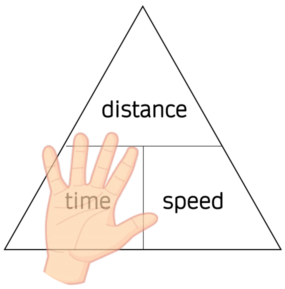
This formula will be given with all assessments (but not what the letters stand for or the units) and you will need to learn where to apply it.

The relationships between distance, time and speed

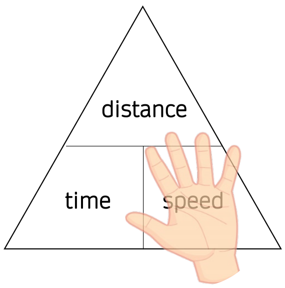
Triangles can be used to calculate speed, distance or time.

Cover the part of the triangle you wish to calculate and multiply or divide the remaining two values.

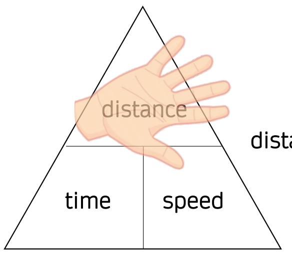
The unit for speed depends upon the units for time and distance but the most common unit in the lab is metres per second (ms^{-1})



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



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



$$\text{distance} = \text{time} \times \text{speed}$$

Speed calculations

A football is kicked and during the first **2s** it travels **36m**. What average speed in ms^{-1} is it going during this time?

v=d/t
v=36m/2s
$v=18ms^{-1}$

A car travels from Cambridge to Hamilton in 15 minutes. The distance is 22.8km. What average speed was the car traveling in $kmhr^{-1}$?

15 minutes / 60mins = 0.25hr
v=d/t
v=22.8km/0.25hr
$v=91.2kmhr^{-1}$

Average speed and instantaneous speed

We calculate **average speed** (velocity). That is the speed that has been travelled on average over the entire distance. In a car the odometer measures **instantaneous speed**. This is the speed that the car is travelling at in that moment.

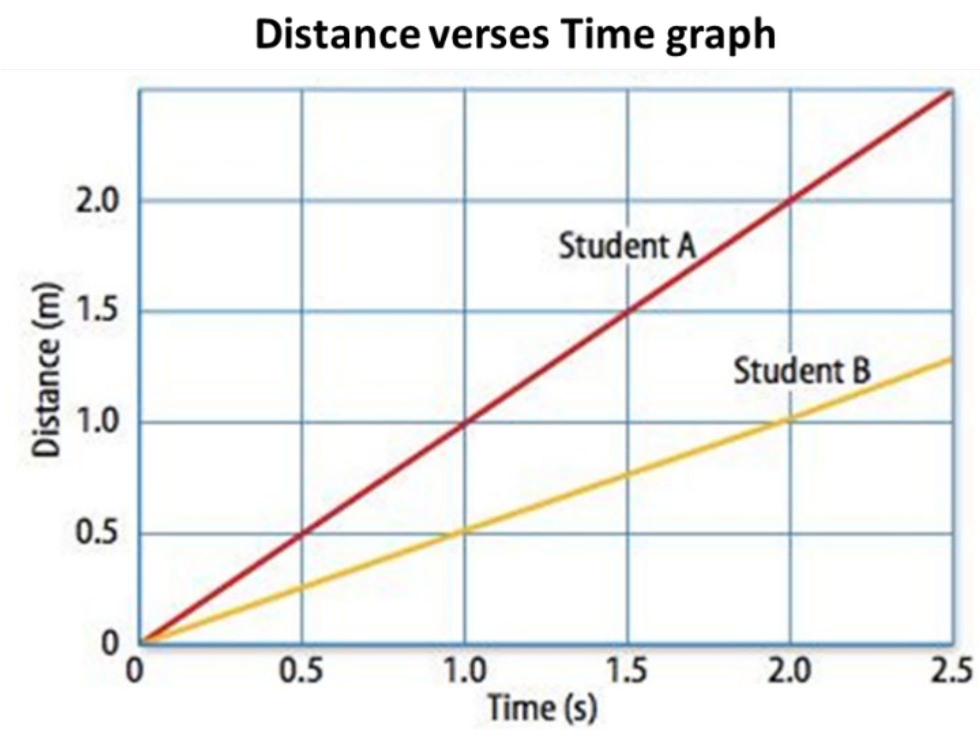
The average speed a car may have been travelling at for a journey from Cambridge to Hamilton may have been 70km per hour but at sometimes they may have been travelling at 100km per hour and at other times they may have been travelling at 45km per hour.

We use the symbol Δ to mean "change in", so using the formula we calculate the average velocity by dividing the change in distance by the change in time taken.

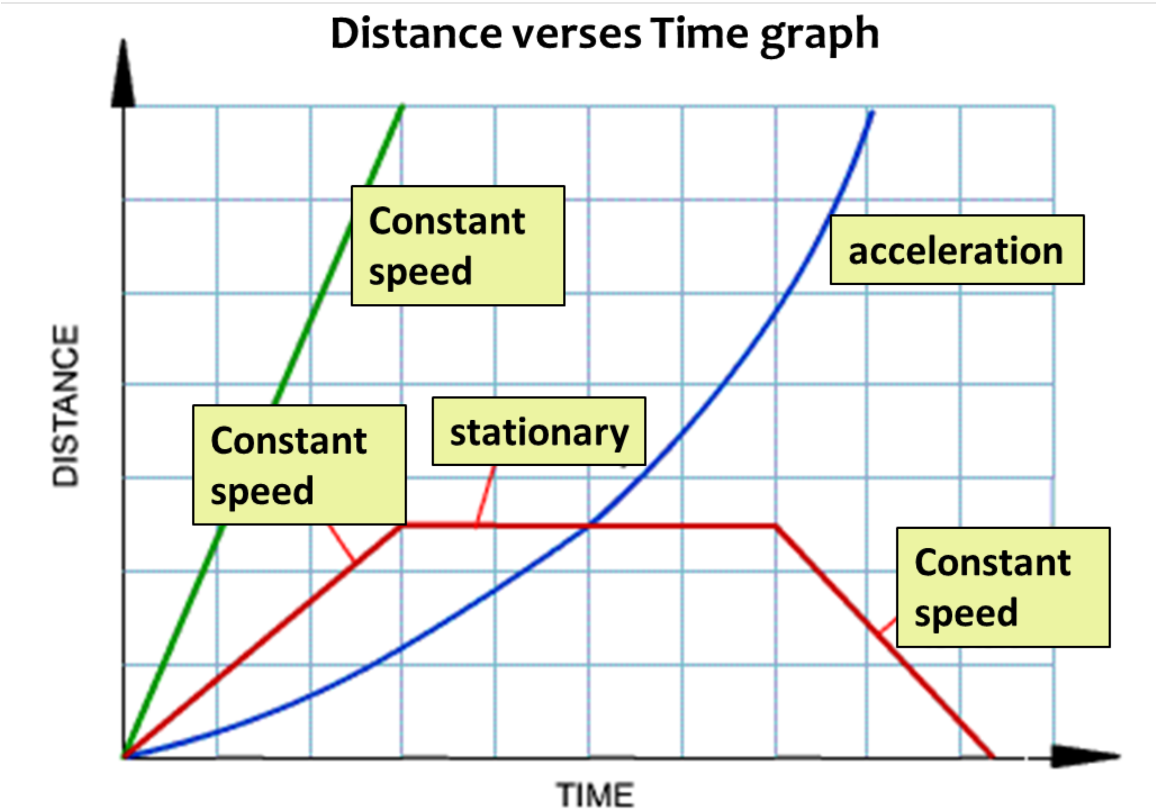
Motion can be represented graphically - Distance vs Time

Distance (y-axis) and time (x-axis) data can be plotted on a graph to show patterns and compare speeds. The steeper line on the right shows student A has a faster speed than student B.

A straight diagonal line indicates **constant speed**. A straight horizontal line indicates the object is **stationary**.



Interpreting Distance/time graphs



A distance time graph can also show **acceleration** with a curved line (blue) because at each time interval the distance travelled becomes larger and larger.

Changes in speed are also shown with a combination of diagonal and horizontal lines (red).

Distance / time graph – Describing motion

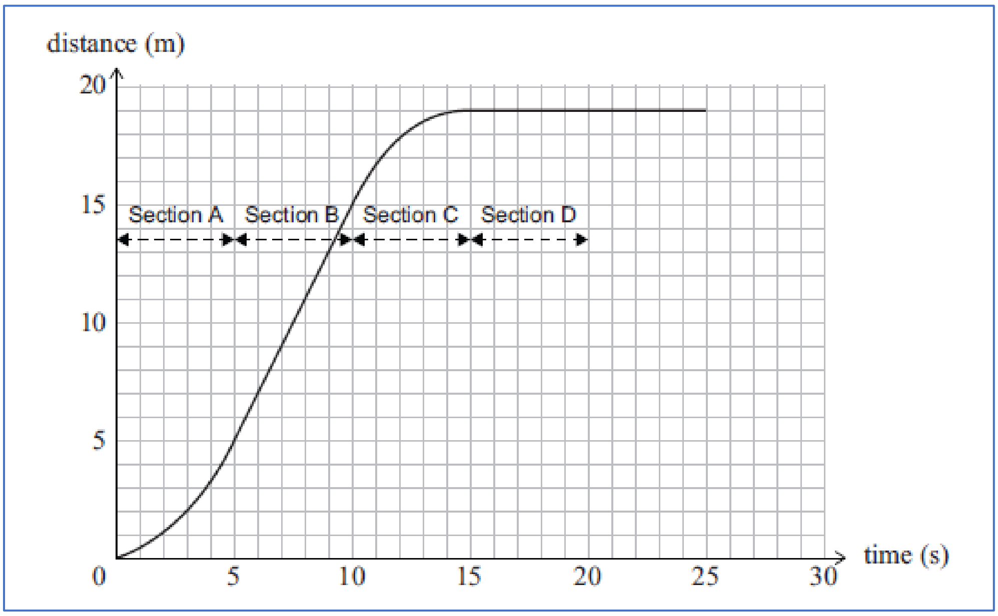
Q1: The cyclist's journey was plotted on the distance / time graph below. Describe the motion of the cyclist in each of sections A, B, C and D

Section A: Increasing speed / accelerating

Section B: Constant speed

Section C: Decreasing speed, decelerating

Section D: Stopped / stationary



Q2: Calculate the cyclists speed during section B.

v = d / t

= 10 / 5

= 2 ms^{-1}

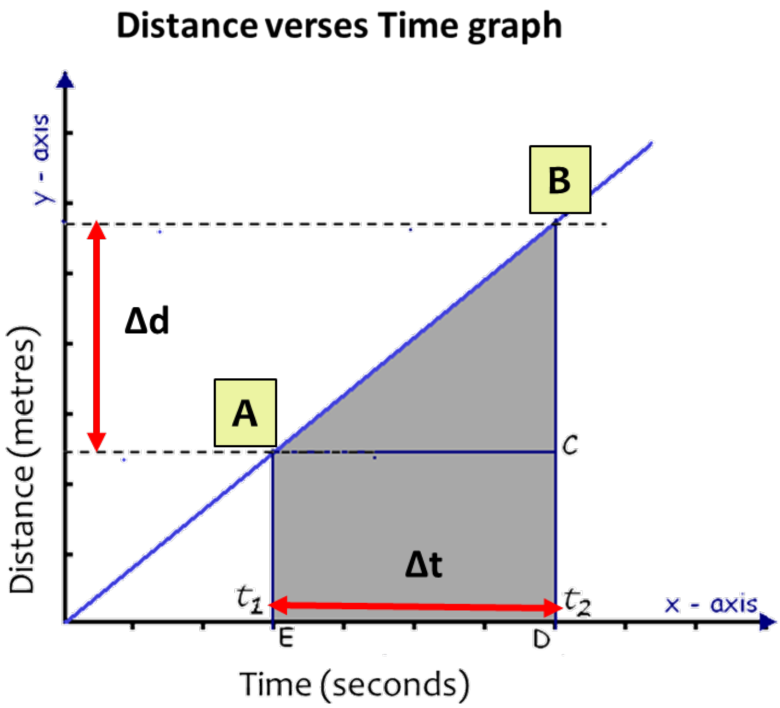
Q3: what is the total distance covered from 5 to 15seconds?

19m – 5m

= 14m in distance covered

Gradients can be calculated from a Distance-time graph - EXTENSION

The **gradient** of a distance - time graph can be used to calculate speed (velocity). The co-ordinates of a straight line in the graph are taken (for example from **A to B**) by projecting back to the x and y axis.



To calculate the value for time, find the difference between **t1 and t2** by subtracting the smallest value from the largest value. This will be your Δ time.

Repeat to find distance on the y axis. This will be your Δ distance.

Place both values into your formula to calculate speed (velocity)

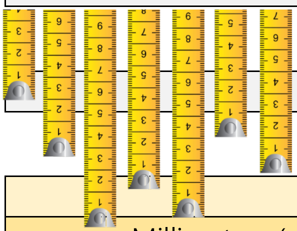
v = Δd/ Δt

Speed Review

1. Units of distance, time and speed can use different scales. Calculate the missing values

1hr = 60mins   1min = 60s

Time		
Seconds (s)	Minutes (min)	Hours (hr)
120		
	45	
		2.5
	240	



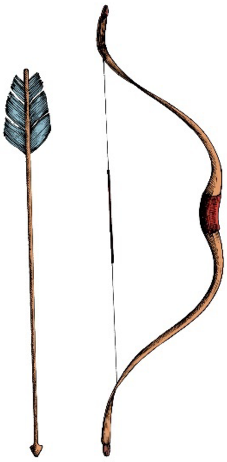
1km = 1000m   1m = 1000mm

Distance		
Millimetres (mm)	Metres (m)	Kilometres (km)
	10.8	
3124		
		0.84
	33	

ms^{-1} to $kmhr^{-1}$ multiply by 3.6 $kmhr^{-1}$ to ms^{-1} divide by 3.6

Speed	
ms^{-1}	$kmhr^{-1}$
	1.4
	27
1576	
	103
	0.57

2. Look at the following situations and calculate the missing values. Remember that v=d/t

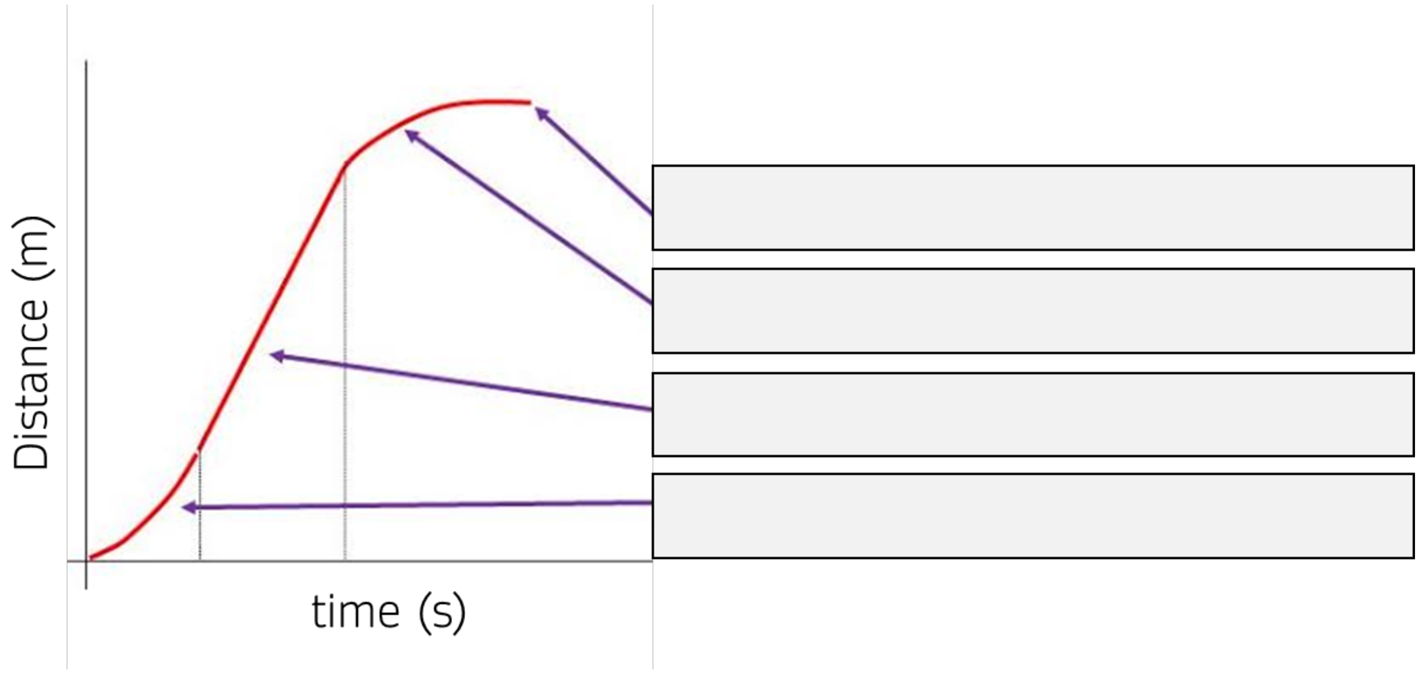
a. A bus trip took 150 mins and during that time 170km was travelled. What was the average speed the bus travelled during that trip in both $kmhr^{-1}$ and ms^{-1}? 	b. A cat travelled 2.5km in one night and had an average speed of $0.6kmhr^{-1}$. What time did it take for the cat to travel this distance? 
c. An arrow can travel at $86ms^{-1}$. Assuming there is no loss of speed, what distance might it travel after 5.5 seconds? 	d. The fastest time for the marathon, a distance of 42.2 km, was set recently by **Eliud Kipchoge** of Kenya on 16 September 2018. He completed it in 2 hours 1 minute and 39 seconds. What average speed did he travel at? 

3. In your own words, define average speed and instantaneous speed.

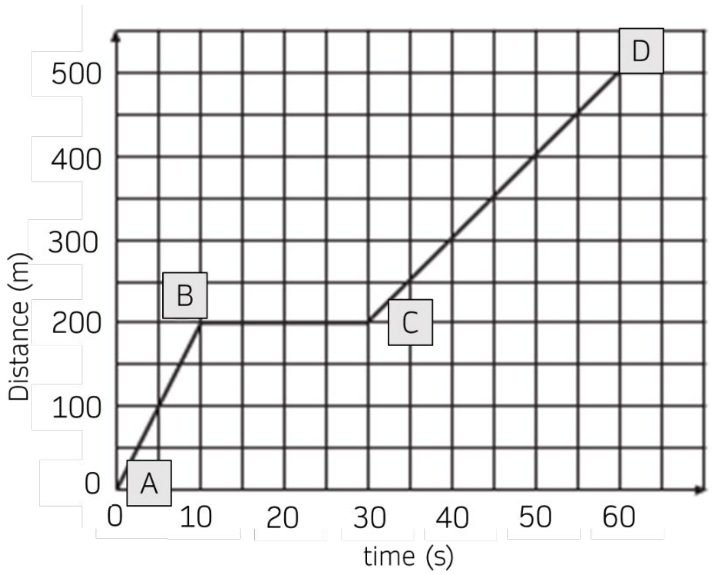
Average speed	Instantaneous speed

4. On the distance-time graph below **add labels** to identify the following features:

Slow constant speed, faster constant speed, acceleration, stationary



5. Use the following graph to answer the questions below.



a. What distance was travelled from point C to D?

b. How long did it take to travel from point C to D?

c. What was the average speed from point C to D?

d. Calculate the average speed travelled from point A to B

e. Compare the speeds of A-B and C-D – using both the calculations and the slope of the graph