



## Section 1 - On the Move

### Average Speed

In this section you can use the equation:

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

also written as

$$\bar{v} = \frac{d}{t}$$

Where  $\bar{v}$  = average speed in metres per second (m/s)  
 $d$  = distance in metres (m)  
 $t$  = time in seconds (s).

1. Find the missing values in the following table.

	Average speed (m/s)	Distance (m)	Time (s)
(a)		100	20
(b)		20	4
(c)	25		0.5
(d)	16		55
(e)	$1.2 \times 10^3$	60	
(f)	75	$1.5 \times 10^4$	

2. A car travels a distance of 2 000 metres in a time of 160 seconds. Calculate the average speed of the car in metres per second.
3. Jane jogs to work every day at an average speed of 4 m/s. Most days it takes her 600 seconds to reach work. Calculate how far she jogs.
4. A model train travels round 10 m of track at an average speed of 1.5 m/s. How long does this take?
5. Christopher takes 26 seconds to swim one length of a swimming pool. If the pool is 50 metres long calculate his average speed.



St. Peter the Apostle  
Physics Department

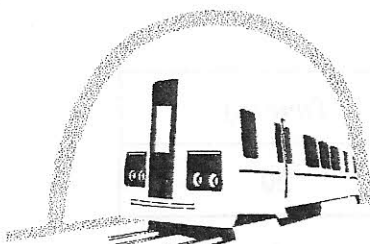


6. How far will a cyclist travel in 60 seconds if he is travelling at an average speed of 13 metres per second?



7. Calculate a hurdler's time if she completes the 400 m hurdle race at an average speed of 7 m/s.
8. How far will a jet aircraft travel in 5 minutes if it flies at 400 metres per second?
9. A train travels at 200 km/h. How far would it travel in 1 second?

10.



The Channel Tunnel is approximately 50 km long. How long will it take a train travelling at 90 m/s to travel from one end of the tunnel to the other?

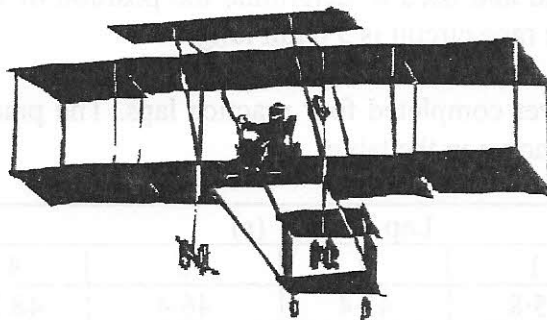
11. A hill walker walks at an average speed of 1.6 m/s. How long will it take her to cover a distance of 33 km?
12. A lorry takes 4 hours to travel 150 km. Calculate the average speed of the lorry in m/s.
13. In 1889 the first Daimler car reached a speed of 20 km/h. How far would the Daimler car travel in 3 hours 30 minutes if it travelled at a constant speed of 20 km/hour?
14. Richard Noble captured the world land speed record in 1983 in his vehicle Thrust 2. The car travelled one kilometre in 3.5 seconds. Calculate the average speed of the car.
15. The French TGV train is the fastest commercial train ever to operate. Its maximum speed is 270 km/hour.
- (a) Calculate its maximum speed in m/s.
- (b) The TGV takes 2 hours to travel the 425 km between Paris and Lyon. Calculate its average speed for this journey in km/h.



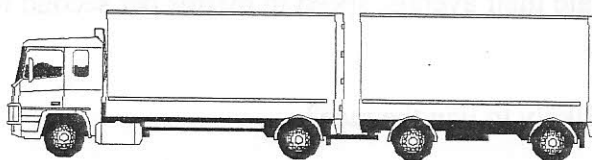
16. The table below shows part of a timetable for the Glasgow to Aberdeen Inter-City Express.

Station	Departure time	Distance (km)
Glasgow	1025	0
Perth	1125	100
Dundee	1148	142
Aberdeen	1324	250

- (a) Calculate the average speed of the train in m/s over the whole journey.
- (b) Between which stations is the train's average speed greatest?
17. The Wright brothers were the first people to fly an aeroplane. Their first flight in 1903 lasted only 12 seconds and covered just 36 metres.



- (a) Calculate the average speed of the plane during that first journey.
- (b) Today Concorde can fly at Mach 2 (twice the speed of sound). How long would it take Concorde to travel 36 metres? (Speed of sound in air = 340 m/s)
18. A long distance lorry driver has 3 hours to travel 210 km to the cross channel ferry.



- (a) Calculate the average speed at which the lorry must travel in order to reach the ferry on time. Give your answer in km/h.
- (b) Due to heavy traffic the lorry has an average speed of 60 km/h for the first 100 km. Calculate how long this leg of the journey takes.
- (c) At what speed must the lorry travel for the rest of the journey if the driver is to catch the ferry? Give your answer in km/h.

St. Peter the Apostle  
Physics Department



19. The cheetah is the fastest mammal on earth. It can run at an average speed of 40 m/s but can only maintain this speed for short periods of time. Cheetahs prey on antelopes. The average speed of an antelope is 35 m/s. The antelope can maintain this speed for several minutes.

- (a) Calculate how far a cheetah could run in 12 seconds if it maintained an average speed of 40 m/s.
- (b) How long would it take an antelope to run 480 m?
- (c) A cheetah is 80 m away from an antelope when it begins to chase it. The antelope sees the cheetah and starts to run at the same instant that the cheetah begins its chase. Both animals run at their average speeds and the cheetah is able to run for 15 s. Show by calculation whether or not the cheetah catches the antelope.

20. Before a major motor race the competitors complete practice circuits in their cars. These practice runs are timed and used to determine the position of each car at the starting grid for the race. The race circuit is 3.6 km long.

In a particular race each driver completed four practice laps. The practice lap times for the top three drivers are shown in the table.

Driver Name	Lap Times (s)			
	1	2	3	4
Mickey	45.8	43.4	46.4	48.2
Donald	44.7	46.2	44.6	49.5
Goofy	46.3	44.8	45.1	43.8

- (a) Which driver had the greatest average speed during lap 1?
- (b) Calculate the greatest average speed during lap 2.
- (c) For each driver calculate their average speed in metres per second for the complete practice run.
- (d) Which driver is most likely to win the race?

## Instantaneous speed

In this section you can use the idea that:

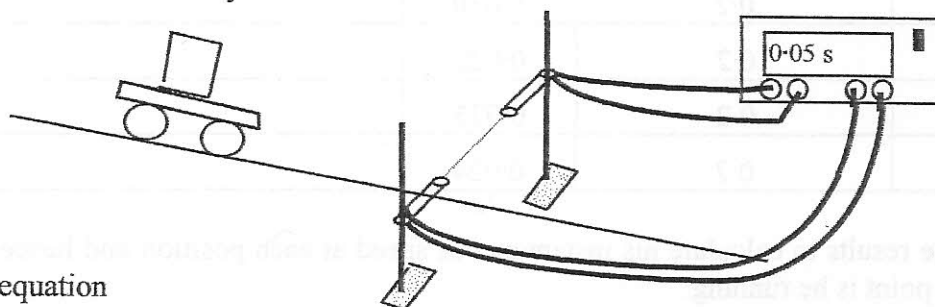
instantaneous speed = average speed over as short a time as possible

also written as

$$v_i = \frac{d}{t}$$

where  $v_i$  = instantaneous speed in metres per second (m/s)  
 $d$  = distance in metres (m)  
 $t$  = time in seconds (s).

1. The following experiment is used for measuring the instantaneous speed of a trolley as it travels down a runway.



Use the equation

$$\text{instantaneous speed} = \frac{\text{width of mask}}{\text{time to cut beam}}$$

to find the missing values in the following table:

	<i>instantaneous speed</i> (m/s)	<i>mask length</i> (m)	<i>time</i> (s)
(a)		0.02	0.1
(b)		0.015	0.1
(c)	4.1	0.03	
(d)	3.5		0.05
(e)	2.0		0.2
(f)	1.86	0.01	

2. An observer wants to find the instantaneous speed of a car as it passes a pedestrian crossing. He measures the length of the car and finds it to be 3.5 m. He then stands with a stop watch at the crossing, starts timing as the front of the car passes him and stops when the back of the car has passed. The time recorded is 2.4 s. Calculate the instantaneous speed of the car.



3. A runner decides to analyse his track performance in order to improve his overall running time during the 400 m event. He sets up light gates at six points round the track so that he can work out his instantaneous speeds at each point. As the runner cuts the beam of light from the light gate the timer operates.

$$\text{instantaneous speed} = \frac{\text{width of runner}}{\text{time to cut beam}}$$

The results he recorded are shown below.

Position	width of runner (m)	time (s)	instantaneous speed (m/s)
A	0.2	0.025	
B	0.2	0.026	
C	0.2	0.030	
D	0.2	0.029	
E	0.2	0.025	
F	0.2	0.024	

Use the results to calculate his instantaneous speed at each position and hence say at which point is he running:

- (a) fastest  
(b) slowest?

4. Civil engineers need to know the speeds of a train as it enters a tunnel which they are planning to build. They set up their equipment to measure the length of a section of the train and time how long that section takes to pass the planned point of entry to the tunnel.

The length of train is 150 m and the time to pass the point of entry is recorded as 1.42 s. Calculate the instantaneous speed of the train.

5. A coin is dropped from a height so that it passes through a light gate connected to a computer. The coin has a width of 0.02 m and it takes 0.005 seconds to pass through the light gate. Find its instantaneous speed.



## Acceleration

In this section you can use the equation:

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time taken}}$$

also written as

$$a = \frac{v - u}{t}$$

where **a** = acceleration in metres per second per second ( $\text{m/s}^2$ )

**u** = initial speed in metres per second ( $\text{m/s}$ )

**v** = final speed in metres per second ( $\text{m/s}$ )

**t** = time taken for change in speed in seconds (s).

1. Find the missing values in the following table .

	<i>Acceleration (<math>\text{m/s}^2</math>)</i>	<i>Change in Speed (<math>\text{m/s}</math>)</i>	<i>Time taken (s)</i>
(a)		12	6
(b)		20	5
(c)	0.05		180
(d)	0.4		600
(e)	3	12	
(f)	5	45	

- A car, starting from rest, reaches a speed of 15 metres per second in a time of 30 seconds. Calculate the acceleration of the car.
- A sprinter in a race crossed the finishing line with a speed of 14  $\text{m/s}$ . If her sprint time was 16 seconds, what was her average acceleration?
- A ball is dropped from the roof of a building. What is the acceleration of the ball if its speed is 30  $\text{m/s}$  after 3 seconds?
- What is the acceleration of a lorry which increases its speed from 5  $\text{m/s}$  to 15  $\text{m/s}$  in 40 seconds?
- A train increases its speed from 15  $\text{m/s}$  to 25  $\text{m/s}$  in a time of 8 seconds. Calculate the acceleration of the train.

