Mechanics

8 Speed, Distance and Time

When we study motion, distance is a scalar quantity that is equal to how far an object has moved. It is measured in metres in SI units. Other units include centimetres, inches, yards, miles and lightyears.

Time is central to the study of motion. It is measured in seconds in SI units. Other units include minutes, hours and days.

Speed is a scalar quantity that is equal to how far an object has moved divided by the time taken. It is measured in metres per second in SI units. Other units include miles per hour, parsecs per jubilee and feet per Julian year: Any speed unit using a distance unit divided by a time unit is valid.

The equation for average speed is:

$$\text{average speed} = \text{total distance} / \text{total time} \quad [v = s/t]$$

In the equation, physicists use v for speed and s for distance. These symbols are useful for more advanced mechanics. Always define your symbols.
Typical speeds are: Walking: 1.5 m/s Running: 3 m/s Cycling: 6 m/s

8.1 Use: speed = distance / time to calculate the missing values.

Distance (m)	Time (s)	Speed (m/s)
100	10	(a)
990	3.0	(b)
2.0×10^3	5.0	(c)
(d)	10	330
(e)	5.0	3.0×10^8
$3\,600$	(f)	12
1.2×10^9	(g)	3.0×10^8
1.7×10^4	(h)	340

8.2 Work out the missing measurements from the following table, where each row is a separate question.

Average speed	Total distance	Total time
330 m/s	(a)	10.0 s
(b)	6.00 km	20.0 µs
3.00 m/s	45.0 m	(c)
(d)	40.1 km	24.0 hours
29.8 km/s	940 Gm	(e)
0.047 0 km/h	(f)	2 min 33 s
(g)	100 m	8.13 s

8.3 A train has an average speed of 100 kilometres per hour. Explain why the maximum speed could be different.

8.4 How far can you run in 15 seconds at an average speed of 8.0 m/s?

8.5 How long does a car take to travel 2.4 km at an average speed of 30 m/s?

8.6 A good long distance runner has an average speed of 5.5 m/s. How far would the runner go in 30 minutes?

8.7 The London-Glasgow shuttle takes approximately 60 minutes to fly a distance of 650 km. Estimate its average speed in m/s.

8.8 The wandering albatross can fly at speeds of up to 32 m/s (the speed limit on motorways!). One albatross was found to have flown 16 250 km in 10 days. Calculate its average speed in metres per second.

8.9 A cross-channel ferry travels at about 7 m/s. At the same average speed, how long would it take to cross the Atlantic Ocean, a distance of 6 700 km? Answer to the nearest hour.

8.10 How many kilometres is a 'light-year' – the distance travelled through space in a year by light travelling at 300 million metres per second?

Additional Speed, Distance and Time Questions

8.11 At what speed does a bowler bowl a ball if it travels the length of the wicket to the batsman (20 metres) without bouncing in 0.45 s?

8.12 Concorde had a top speed of around 2 180 km/h; (that is, about twice the speed of sound in air, 340 m/s). Calculate its time to fly across the Atlantic Ocean from London to New York at this speed, a distance of 7 600 km.

8.13 A sock on the rim of a washing machine drum whilst it is spinning goes round in a circular path of radius 20 cm at a rate of 15 times per second. Calculate the speed of the sock in metres per second. Remember that the circumference of a circle, $c = 2\pi r$.

8.14 A marathon race is run over a distance of 42 730 metres. A top runner can complete the course in 2 hours 15 minutes. Calculate the average speed of the runner in metres per second.

8.15 Calculate the speed of a point on the Earth's equator as the Earth rotates once each day. The radius of the Earth is 6400 km.

8.16 Calculate the speed of the Earth in its orbit around the Sun if the radius of the orbit is 1.50×10^{11} m.

8.17 A delivery person starts their delivery round at 6:30am. They travel a total distance of 5.00 km. At 7:53am the delivery round ends. What was their average speed?

8.18 A police constable drives down a motorway with an average speed of 110 kilometres per hour. How far does the police constable travel in 15.0 seconds?

8.19 A groom is marrying his partner at 1:00pm. The wedding venue is 6.00 km away from their house and the average journey speed is 40 kilometres per hour. What is the latest time he can leave his house in order to arrive on time?