4 Describing Motion

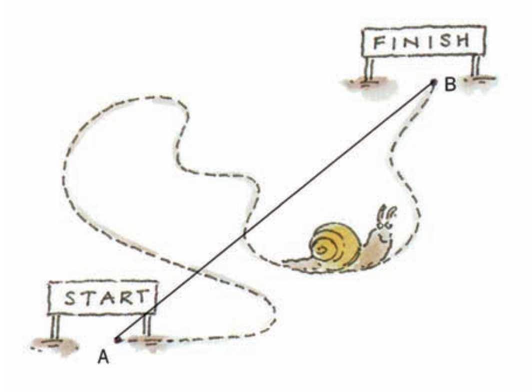
We live in a world full of movement. Humans, animals and the many forms of transport we use are obvious examples of objects designed for movement. This chapter is about the Physics of motion.

In this chapter you will learn:
- how to describe motion in terms of distance, displacement, speed, velocity, acceleration and time,
- how to use equations that link these quantities,
- how to draw and interpret graphs representing motion.

Distance and displacement

Distance and displacement are both ways of measuring how far an object has moved. So what is the difference?

Distance is a scalar. Displacement is a ***vector*** quantity (see page 10). Displacement is the distance moved in a particular direction.



The snail in the picture moves from A to B along an irregular path:
The ***distance*** travelled is the total length of the dashed line.

But what is the snail's ***displacement***?
The magnitude of the displacement is the length of the straight line AB. The direction of the displacement is along this line.

Speed and velocity

The speed of an object tells you the distance moved per second, or the ***rate of change of*** distance:

$$\textbf{average speed} = \frac{\textbf{distance travelled}\ (\text{m})}{\textbf{time taken}\ (\text{s})}$$

Speed is a scalar quantity, but velocity is a vector.

Velocity measures the rate of change of ***displacement***:

$$\textbf{average velocity} = \frac{\textbf{displacement}\ (\text{m})}{\textbf{time taken}\ (\text{s})}$$

Both speed and velocity are measured in **metres per second**, written **m/s** or **m s^{-1}**. With velocity you also need to state the direction.

Using these equations you can find the ***average*** speed and the ***average*** velocity for a car journey.
A speedometer shows the actual or ***instantaneous*** speed of the car. This varies throughout the journey as you accelerate and decelerate.

So how can we find the instantaneous speed or velocity at any point? The answer is to find the distance moved, or the displacement, over a very small time interval. The smaller the time interval, the closer we get to an instantaneous value (see also page 40).

Military jet 450 m s^{-1}

Racing car 60 m s^{-1}

Cheetah 27 m s^{-1}

Sprinter 10 m s^{-1}

Tortoise 0.060 m s^{-1}