Exercise 1.1 Displacement, distance, speed and velocity

The following questions will help you to improve your skill with calculations involving displacement, speed, velocity and acceleration.

1   a   Explain the difference between *distance* and *displacement*.

   b   Explain the difference between *speed* and *velocity*.

2   Calculate the speed, in ms^{-1}, of a:

   a   car that travels 200 km in 90 minutes; suggest why your answer is an average speed

   b   sound wave that reaches an observer's ears having travelled 1.5 km in 4.5 s

   c   transatlantic liner that takes five days to travel 6000 km.

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3   A high-speed train travels between Beijing and Tianjin. If the train travels at a speed of 97 ms^{-1}, calculate the time it takes for the train to travel the 117 km journey.

4   Proxima Centauri is the closest star to our Sun. It is 3.78×10^{16} m from the Earth. (The speed of light, $c = 3.0 \times 10^8$ ms^{-1})

   a   Calculate the time it takes for light to travel from Proxima Centauri to the Earth.

   b   How else could the distance from Proxima Centauri to the Earth be stated?

> **TIP**
>
> To solve calculation questions, begin by writing the equation you want to use; then put in the numbers and then write the answer. Don't forget to use the correct amount of significant figures and don't forget to include the correct units.

5   Calculate the acceleration in the following situations:

   a   A boy walking along the road changes his speed from 0.6 ms^{-1} to 1.2 ms^{-1} in a time of 1 minute.

   b   The velocity of an electron changes from 0.0 ms^{-1} to 2×10^7 ms^{-1} in a time of 4.0 ns.

   c   An aeroplane approaching an airport changes its speed from 90 ms^{-1} to 30 ms^{-1} in a time of 20 minutes.

6 An athlete running at a constant speed moves around a bend in the track. Explain why the athlete has accelerated even though his speed has not changed.

7 A molecule of nitrogen in the air travels 3 cm horizontally and 4 cm vertically in a time of 100 μs.

   a Calculate the magnitude of the overall displacement of the molecule.

   b Calculate the average speed of the molecule.

   c Calculate the direction in which it has travelled relative to the horizontal.

   d State its average velocity during the 100 μs period.

8 On the horizontal surface of a flat table, the co-ordinates, in cm, of a ball change uniformly from (1, −1) to (5, 5) during a time of 4.0 s.

   a Calculate the magnitude of the overall displacement of the ball.

   b Calculate the average speed of the ball.

   c By writing the overall displacement of the ball as the x- and y-components of a vector, calculate the angle to the x-axis of the motion of the ball.

   d State the velocity of the ball during the 4.0 s period.