

Distance and displacement

4.5.6.1.1 · Forces · revision notes

Distance is how far an object moves; displacement is how far it ends up from its starting point in a straight line, with a direction. Expect short recall questions and calculations of distance and displacement for journeys, often with a diagram or a map.

Key facts

- Distance = how far an object moves (scalar, m)
- Displacement = straight-line distance from start to finish, with a direction (vector)
- Displacement needs a magnitude and a direction
- Distance travelled $\geq$ size of the displacement
- Back at the start $\rightarrow$ displacement = 0
- Along a line: one direction +, the other –

Notes

Distance

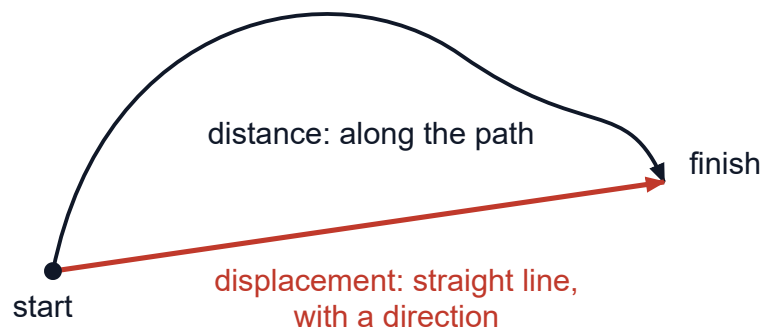
- Distance is how far an object moves along its path.
- Distance does not involve direction, so it is a **scalar** quantity. Its unit is the metre (m).
- For a journey with several parts, add up the lengths of all the parts.

Displacement

- Displacement includes both the distance an object moves, measured in a straight line from the start point to the finish point, and the direction of that straight line.
- Displacement is a **vector** quantity. Give its magnitude and its direction, e.g. 120 m north, or 30 m on a bearing of 045° .
- For motion along a straight line, choose one direction as positive: 5 m to the right is +5 m and 5 m to the left is –5 m.

Comparing distance and displacement

- The distance travelled is always greater than or equal to the size of the displacement.



Distance follows the path; displacement is the straight line from start to finish.

- They are equal only when the object moves in one direction along a straight line.
- If an object ends where it started, e.g. after one 400 m lap of a running track, its displacement is zero but the distance travelled is 400 m.

How to answer each type of question

Explain the difference between distance and displacement

2 marks

Grade 4

- Distance: the length of the whole path, with no direction.
- Displacement: the straight line from start to finish, with a direction.

Example. A runner completes exactly one lap of a 400 m track.
State the distance travelled and the displacement of the runner. Explain your answers.

Model answer. Distance = 400 m, because distance is the length of the path followed (1).
Displacement = 0 m, because the runner finishes at the start point (1).

Calculate distance and displacement along a line

3 marks

Grade 5

- Distance: add the lengths of all the parts.
- Displacement: take one direction as positive and the other as negative, then add.
- Give the displacement with a direction.

Example. A dog runs 35 m east along a beach, then 12 m west.
(a) Calculate the total distance the dog travels.
(b) Calculate the displacement of the dog from its starting point.

Model answer. (a) $35 + 12 = 47$ m (1)
(b) $35 - 12 = 23$ m (1) east (1)

Don't lose marks

- ✗ Giving a displacement without a direction.
- ✗ Adding the parts of an out-and-back journey to find the displacement instead of subtracting them.
- ✗ Saying distance and displacement are the same thing.
- ✗ In scale drawings, not saying which direction an angle is measured from.

More tips

Memory tricks

- Displacement = 'as the crow flies, plus which way'.
- Distance: add everything. Displacement: use + and – for opposite directions.
- Right-angled journeys often use 3-4-5 triangles: 30 and 40 give 50; 0.9 and 1.2 give 1.5.

Exam technique

- Use the words 'magnitude and direction' when you define displacement.
- If a question uses compass directions, give your answer with a compass direction or a bearing.
- Show your Pythagoras working, or write the scale you used for a scale drawing.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State that distance is a scalar

Distance is how far an object moves; it does not involve direction.

Grade 4

State that displacement is a vector

Displacement is the straight-line distance from the start point to the finish point, with the direction of that line.

Grade 5

Calculate distance and displacement along a line

40 m east then 15 m west: distance 55 m, displacement 25 m east.

Grade 5

Explain why displacement can be zero

After a round trip back to the start, the displacement is zero although the distance travelled is not.

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