SCIENCE FOUNDATIONS

Distance versus displacement

Difficulty level: Intermediate

Science Foundations

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Overview of the concept

This is how you tell the difference between the total kilometres on your odometer after a winding drive and how far you actually ended up from home in a straight line. A runner who does ten laps of a track covers a long distance but ends up right where they started. A delivery driver cares about the road distance, while a pilot flying straight cares about the displacement. Knowing the difference tells you when the length of the journey matters and when only the start and finish count.



Rule

Distance versus displacement: distance is the total length of the path travelled, and it is never negative.

Displacement is the straight-line distance from the start to the finish, with direction, and it can be zero even when the distance is not.

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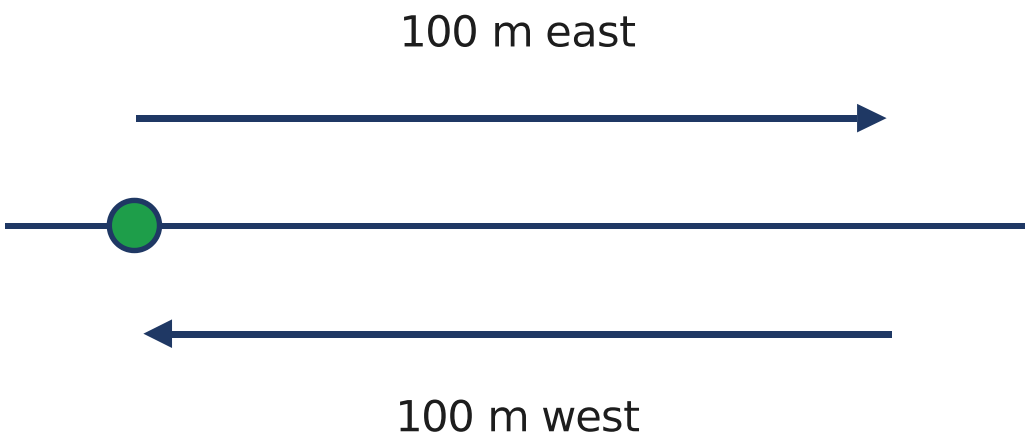
Worked examples

EXAMPLE 1

Q A runner goes 100 m east, then 100 m west. Distance and displacement?



SOLUTION

Add the path:

100 + 100 = 200 m

Find start to finish: the runner ends where she started.

State displacement: zero.

The result is distance 200 m, displacement 0 m.

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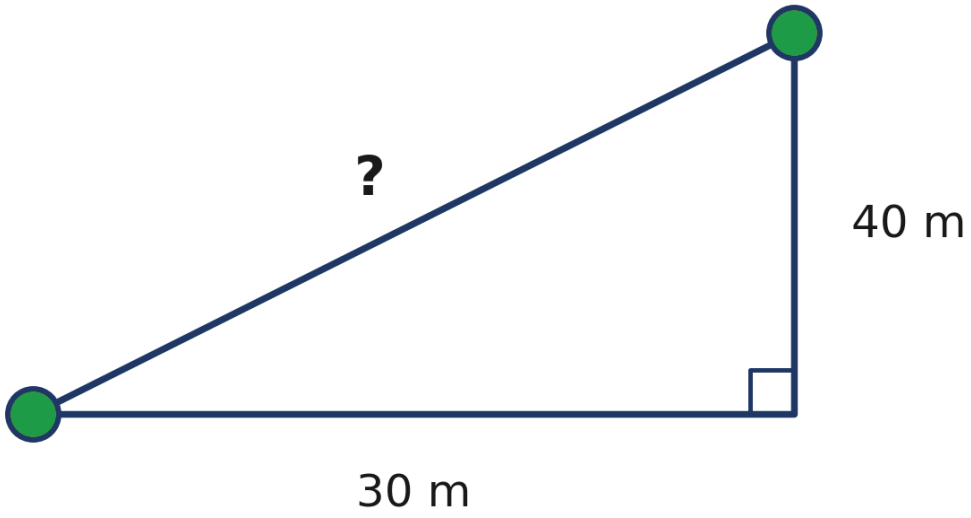
EXAMPLE 2

Q A walker goes 30 m east, then 40 m north. Displacement size?



SOLUTION

Draw the path at right angles: one side is 30 m and the other side is 40 m.

Use Pythagoras:
$d^2 = 30^2 + 40^2$.

Take $\sqrt{2500}$:
$d = \sqrt{2500} = 50$ m

The result is displacement 50 m northeast (direction from the path).

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Practice questions

1 A swimmer swims 50 m down the pool, then 50 m back. What are the distance and the displacement?

- **A** Distance 100 m, displacement 0 m
- **B** Distance 0 m, displacement 100 m
- **C** Distance 50 m, displacement 50 m
- **D** Distance 100 m, displacement 100 m

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2 A cyclist rides 3 km east, then 4 km west. What are the distance and the displacement?

- **A** Distance 7 km, displacement 1 km west
- **B** Distance 7 km, displacement 0 km
- **C** Distance 1 km, displacement 7 km west
- **D** Distance 7 km, displacement 1 km east

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3 A hiker walks 9 m east, then 12 m north. What is the size of the displacement?

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4 A hiker walks 8 m east, then 6 m north, then 8 m west. What is the size of the displacement?

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5 Walk 5 m east: distance and displacement?

A. Distance 5 m, displacement 5 m east

B. Distance 5 m, displacement 0 m

C. Distance 0 m, displacement 5 m east

D. Distance 10 m, displacement 5 m east

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6 Round trip distance 400 m: displacement?

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7 Is distance ever negative?

A Yes

B No

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8 Can displacement be zero?

A Yes

B No

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9

Distance is total what?

A Total path length

B Straight-line distance from start to finish

C Direction of travel

D Time taken

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10

Which is a vector (a quantity with a size and a direction): distance or displacement?

A Displacement

B Distance

C Both

D Neither

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ANSWER KEY

1. Distance 100 m, displacement 0 m

2. Distance 7 km, displacement 1 km west

3. 15 m

4. 6 m

5. Distance 5 m, displacement 5 m east

6. 0 m

7. No

8. Yes

9. Total path length

10. Displacement

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