

Speed and distance-time graphs

Name: _____ Class: _____ Date: _____

Start here

0-5 minutes

Today: Calculate speed, read distance-time gradients and draw a graph from data.

You need: Pen, a different-coloured pen, ruler and calculator. Graph grid supplied.

Work from memory. Write in this booklet and show working. If unsure, make your best attempt.

1. A robot travels 18 m in 6.0 s. Calculate its average speed, including the unit.

Working:

Average speed = _____ m/s

2. Convert 1.5 minutes into seconds.

3. On a total-distance-time graph, a horizontal section stays at 12 m from 8 s to 14 s. Describe the motion and state the speed in that interval.

Stop for check 1. Wait for your teacher before moving on.

Try again A

Only if your teacher asks. Use the first 2 reading minutes, then continue on page 2.

Help: Use the equations and graph rules on pupil page 2. Multiply minutes by 60. A flat total-distance line means no additional distance.

(a) Calculate average speed for 24 m in 6.0 s. (b) Convert 0.50 minutes to seconds. (c) A total-distance graph stays at 15 m from 5 s to 9 s. Describe the motion and state the speed.

When your teacher says, turn to page 2.

Read the rules and model

5-15 minutes

Speed tells us distance covered per unit time. On a total-distance-time graph, height is the distance already travelled; gradient gives speed. Total distance cannot decrease, even when the object returns towards its start.

Find...	Equation / consistent units
Average speed	Total distance / total elapsed time, including stops.
Distance in a constant-speed stage	Speed $\times$ time.
Time in a constant-speed stage	Distance / speed.
Units	Distance: m; time: s; speed: m/s. Minutes $\times$ 60 gives seconds.

A graph section needs two changes

Choose two points on that straight section. Speed = (later distance - earlier distance) / (later time - earlier time). A steeper line means a greater speed. A horizontal line means stationary, however high it is.

Worked model - the revision-note runner

The revision-note runner travels 150 m in 30 s at constant speed. Find the gradient of the distance-time graph.

Speed = change in distance / change in time = $150 / 30 = 5.0$ m/s. A straight sloping line means constant speed.

Whole journeys and returns

Divide the full distance by the full elapsed time, including stops. Do not average section speeds without accounting for the time in each section. Distance adds the route travelled; displacement would describe start-to-finish separation and direction.

Reading adapted from PhysicsUK: Motion Graphs, Speed and Acceleration, shared parts of sections 1-2. Online reading is optional. Optional online reading.

Turn to page 3 for question 4.

Choose the method, then begin practice

15-20 minutes; start practice at 20 minutes

4. A straight section of a total-distance-time graph joins (2 s, 5 m) to (6 s, 17 m). What is the speed during this section? Choose a letter and show both changes.

- A. 2.8 m/s
- B. 3.0 m/s
- C. 12 m/s
- D. 0.33 m/s

Change in distance = _____ m; change in time = _____ s

Working and chosen letter:

Stop for check 2. Wait for your teacher before moving on.

Try again B

Only if your teacher asks. Complete this instead of questions 5-6, then answer questions 7-10.

Help: Use the endpoint method on page 2. Subtract the two distances and the two times before dividing. The section does not start at the graph origin.

A straight distance-time section runs from (4 s, 10 m) to (9 s, 30 m). Calculate its speed using changes in both quantities.

Practice - separate delivery tests

Questions 5 and 6 concern separate tests. A delivery robot carries parcels along a straight lane.

5. Two separate deliveries each cover 12 m at constant speed. Calculate the time at 1.5 m/s, then at 2.0 m/s.

At 1.5 m/s - working:

Time = _____ s

At 2.0 m/s - working:

Time = _____ s

6. Near pedestrians the speed limit is 1.5 m/s. In a test the robot covers 12 m in 5.0 s. Calculate its average speed and decide whether it could have stayed within the limit throughout.

Average speed - working:

Average speed = _____ m/s

Decision and reason:

Continue with Figure 1 and questions 7-10 on page 4.

Read the delivery graph

20-30 minutes

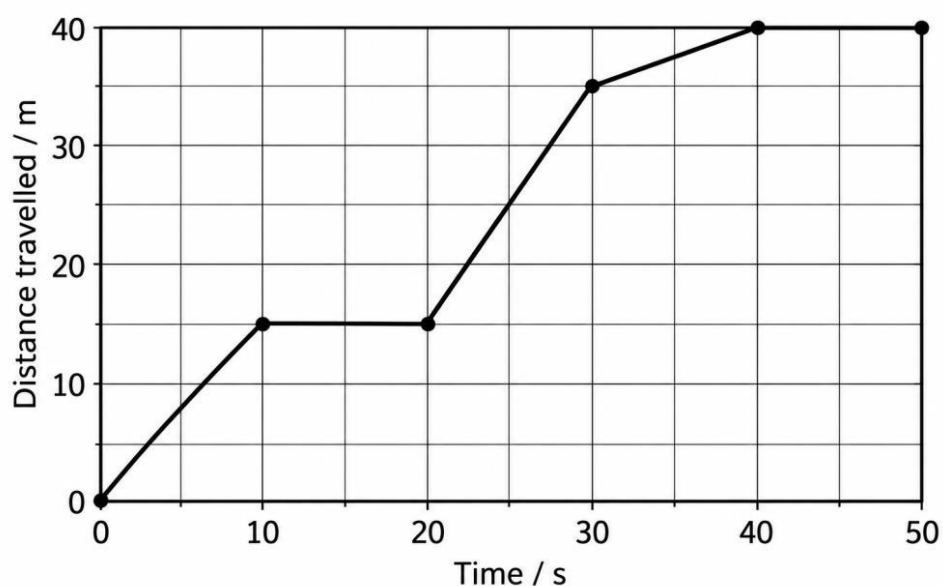


Figure 1: total distance travelled. The robot moves east in 0-10 s, west in 20-30 s and east in 30-40 s. Total distance is not signed position.

7. Use Figure 1 to read the total distance travelled by 5.0 s.

8. Use Figure 1 to read the total distance travelled by 25 s.

9. State both time intervals in Figure 1 when the robot is stationary.

10. Calculate the speed from 0-10 s in Figure 1 using the gradient.

Changes and division:

Speed = m/s

At about 30 minutes, turn to page 5 for the independent check.

Pause, then calculate section speeds

30-33 minutes; then continue practice

11. In a separate run a robot travels from 0 m at 0 s to 12 m at 4 s, then stays at 12 m until 8 s. State the rest interval and calculate its average speed over the whole 8 s.

Rest interval:

Average-speed working:

Average speed = m/s

Stop for check 3. Wait for your teacher before moving on.

Try again C

Only if your teacher asks. Complete this instead of questions 12-13, then continue with questions 14-19.

Help: Use the whole-journey rule on page 2. Rest adds elapsed time but no distance. Use the complete stated time interval.

A cart travels 16 m during 0-4 s, then waits until 8 s. State the rest interval and calculate average speed for the complete 8 s.

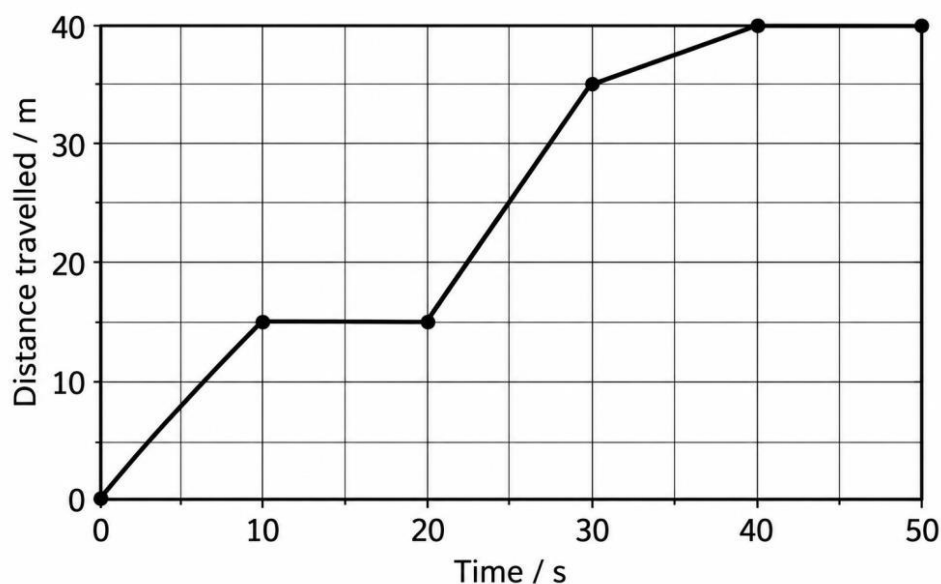


Figure 1: total distance travelled. The robot moves east in 0-10 s, west in 20-30 s and east in 30-40 s. Total distance is not signed position.

12. Calculate the speed from 20-30 s in Figure 1.

Changes and division:

Speed = m/s

Continue with the same Figure 1 on page 6.

Explain the whole journey

33-45 minutes - continue practice

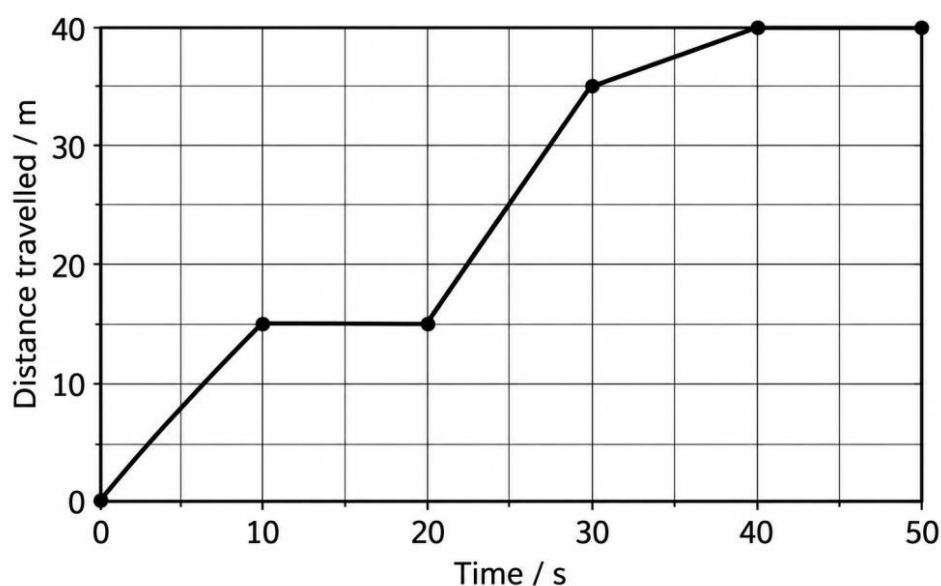


Figure 1: total distance travelled. The robot moves east in 0-10 s, west in 20-30 s and east in 30-40 s. Total distance is not signed position.

13. Calculate the speed from 30-40 s in Figure 1.

Changes and division:

Speed = m/s

14. Calculate the average speed over the full 50 s in Figure 1. Explain why the stopped time must be included.

Working:

Average speed = m/s

Why include stopped time?

15. State the interval with the greatest speed in Figure 1. Explain which graph feature shows this.

16. A pupil expects the line to fall from 20-30 s because the robot moves west. Explain why this total-distance graph still rises.

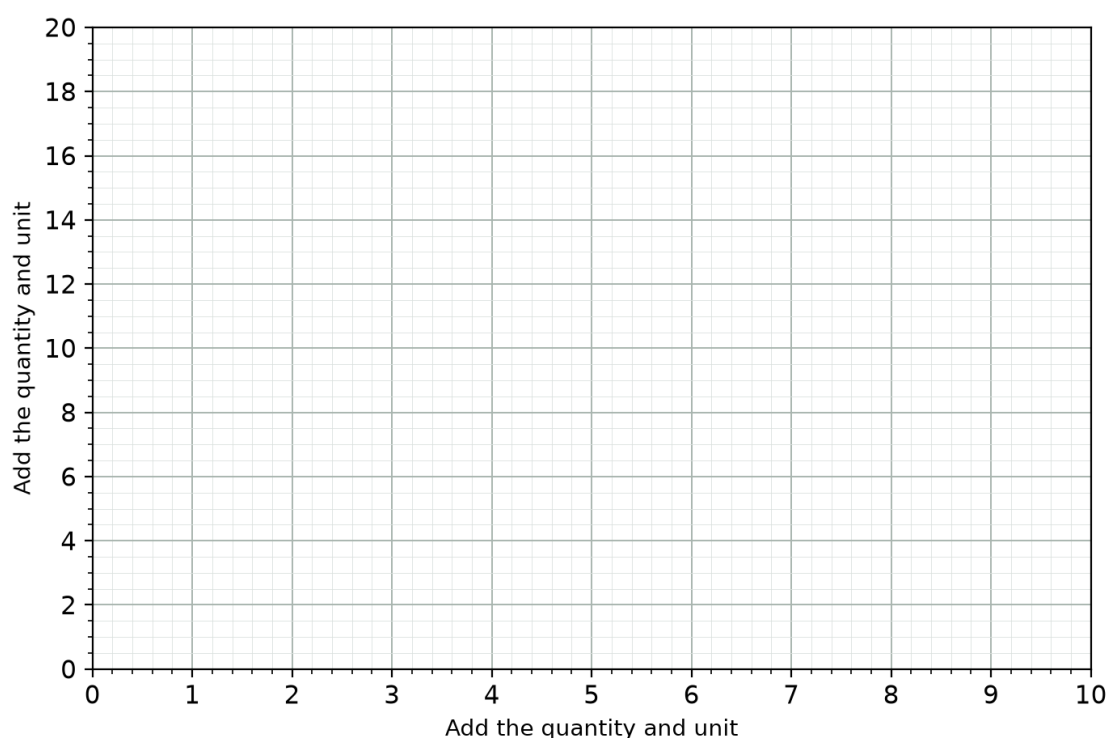
Finish practice by drawing the different robot graph on page 7.

Draw a new robot graph

Finish practice by 45 minutes

This is a different run, adapted from the revision note's original practice question 3. Do not use Figure 1 data.

17. A different robot has total distance readings (0 s, 0 m), (3 s, 6 m), (5 s, 6 m) and (9 s, 18 m). Motion between readings is uniform. On the supplied grid, label both axes with quantities and units, plot all four points and join consecutive points with straight lines.



Grid for question 17. Add the axis quantities and units; scales are supplied. Use a ruler for the straight sections.

18. Using the graph you drew for question 17, identify the rest interval and calculate the greatest speed. Show the two endpoint changes for the fastest section.

Rest interval:

Fastest section - working and speed:

19. Calculate the average speed for the whole 9 s of the run in question 17.

Working:

Average speed = m/s

At 45 minutes, turn to page 8 to review, then complete the final check.

Review, then show what you can do

45-55 minutes review; 55-60 minutes independent exit

20. Check the practice answers in a different colour. Explain one correction using the relevant equation or graph feature. If all were correct, use Figure 1 to explain why the highest part of a distance-time graph need not show the greatest speed.

Independent exit - only when your teacher says

Cover the earlier pages and your previous answers. Complete question 21 on your own.

21. A new cart has total distance readings (0 s, 0 m), (2 s, 8 m), (5 s, 8 m), (8 s, 14 m). Motion between readings is uniform. (a) State the rest interval. (b) Calculate the speeds during 0-2 s and 5-8 s; state which is faster. (c) Calculate average speed over the complete 8 s.

(a) Rest interval:

(b) First speed - working and unit:

Last speed - working and unit; which is faster?

(c) Whole-journey average - working and unit:

Stop for check 4. Wait for your teacher before moving on.

Write your name on page 1. Hand in the whole booklet, including working and corrections.

Try again D - next lesson

Leave this today. Your usual teacher may ask you to do it next lesson.

Help: Next lesson, revisit the endpoint and whole-journey methods on page 2. Then cover the reading before attempting this new run.

Next lesson: a cart has readings (0 s, 0 m), (2 s, 6 m), (4 s, 6 m), (8 s, 12 m). Motion between readings is uniform. Identify the rest interval, calculate each moving-stage speed, then find average speed for all 8 s.

Hand your complete booklet to your teacher.