

Covering teacher guide

Speed and distance-time graphs

Start here / subject briefing

Before this lesson: Consolidation after pupils have met speed calculations, simple graph axes and distance-time graphs. A ruler and calculator are needed; no experiment is required.

A total-distance graph shows how much route has accumulated. Its height is distance; its gradient is speed. For a straight section use changes between two points, even when the section starts away from the origin. A horizontal line means stopped. Whole-journey average speed includes stopped time. Returning still increases total distance.

Words and symbols you will need

Term	Plain-English meaning
Speed (m/s)	Distance covered per second; direction is not included.
Total distance (m)	The accumulated route travelled, even after a return.
Elapsed time (s)	All the time between the stated start and finish, including stops.
Gradient	Change in vertical distance value divided by change in horizontal time value.
Stationary	Not moving; no additional distance is travelled.

Help pupils choose a method

1. Name the interval. Read two points from the same straight graph section.
2. Subtract distances and times separately, then divide distance change by time change.
3. For a whole-journey average, use the full distance and full elapsed time. Check units and whether the slope matches the motion.

Use the supplied model - pupil page 2

Use the runner model on pupil page 2: 150 m in 30 s gives 5 metres each second. This model starts at zero; question 4 deliberately does not, so both endpoint differences matter.

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

If pupils are still stuck

Read the relevant Say/Ask/Expect coaching and use the named fresh retry within its replacement time. If it remains insecure, help the pupil write the two changes or the correct whole-journey fraction, then record the specific difficulty for the usual teacher.

Turn to teacher page 2 for the timed run sheet. Keep this guide separate from the pupil booklet.

Run the lesson from this page

Speed and distance-time graphs

Print the complete 8-page pupil booklet in order, one per pupil. Staple each booklet; double-sided printing is fine.

Read the subject briefing on teacher page 1, then use the timed run sheet on page 2. Keep this guide separate from pupil copies.

Pupils need pens, a ruler and a calculator. The graph grid, source figure, reading and data are included; no login, devices or apparatus are required.

Min	Pupil page / Q	Read aloud / check	Next action and answer key
0-5	1 / 1-3	Start from memory on page 1. At 5 minutes, check the three answers.	If insecure, use Try again A in the first 2 reading minutes. Answers: teacher page 3. Coaching: page 7.
5-15	2 / reading	Read the equation table and graph rules. Follow the runner model.	Check Try again A if used; then continue the reading.
15-20	3 / 4	Choose a letter and show both endpoint changes. Stop at check 2.	If insecure, Try again B replaces questions 5-6. Answers: teacher page 3. Coaching: page 8.
20-30	3-4 / 5-10	Complete the delivery calculations and Figure 1 questions.	If Try again B was used, leave 5-6 blank. Require units and changes. Answers: teacher page 4.
30-33	5 / 11	Pause and complete question 11 independently.	If insecure, Try again C replaces questions 12-13. Answers: teacher page 4. Coaching: page 9.
33-45	5-7 / 12-19	Continue the graph calculations, then draw the different robot graph on page 7.	The grid is supplied. If C was used, leave 12-13 blank; complete 14-19. Answers: teacher page 5.
45-55	8 / 20	Correct practice in a different colour. Explain one correction.	Share only practice answers. Keep the exit answer hidden. Answers: teacher page 5.
55-60	8 / 21	Cover earlier pages. Complete question 21 independently.	Collect every booklet. Check the exit afterwards; D is next lesson only. Answers: teacher page 6. Coaching: page 10.

Estimated 60 minutes. Practice: 10 minutes, a 3-minute check and 12 minutes, including the supplied-grid graph. A uses reading time; B replaces 5-6; C replaces 12-13; D is next lesson only. Timings are not classroom-trialled.

Entry and hinge - pupil pages 1 and 3

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

1. (pupil p1) $18 / 6.0 = 3.0 \text{ m/s}$.

2. (pupil p1) $1.5 \times 60 = 90 \text{ s}$.

3. (pupil p1) Stationary: total distance does not change. Speed = 0 m/s. The height 12 m is a distance, not a speed.

4. (pupil p3) B: distance change = $17 - 5 = 12 \text{ m}$; time interval = $6 - 2 = 4 \text{ s}$; speed = $12 / 4 = 3.0 \text{ m/s}$.

Try again A - pupil page 1

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

(a) 4.0 m/s. (b) 30 s. (c) Stationary, 0 m/s: no distance is added.

Try again B - pupil page 3

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

Distance change = 20 m; time interval = 5 s; speed = 4.0 m/s.

First practice and mid-check - pupil pages 3-5

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

5. (pupil p3) $t = \text{distance} / \text{speed}$. First: $12 / 1.5 = 8.0$ s. Second: $12 / 2.0 = 6.0$ s.

6. (pupil p3) Average speed = $12 / 5.0 = 2.4$ m/s. No: the average exceeds 1.5 m/s, so the speed must exceed the limit at some time. An average below a limit would not prove that every instantaneous speed was below it.

7. (pupil p4) 7.5 m. Accept 7.0-8.0 m for a clear reading from the supplied graph.

8. (pupil p4) 25 m: halfway between 15 m at 20 s and 35 m at 30 s.

9. (pupil p4) 10-20 s and 40-50 s. The total distance is unchanged in both intervals.

10. (pupil p4) $(15 - 0) / (10 - 0) = 1.5$ m/s.

11. (pupil p5) Rest: 4-8 s. Whole-journey average = $12 / 8 = 1.5$ m/s. Include the stopped time; $12 / 4 = 3$ m/s describes only the moving stage.

Try again C - pupil page 5

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

Rest: 4-8 s. Average speed = $16 / 8 = 2.0$ m/s. The whole time includes the stop.

Later practice, new graph and review - pupil pages 5-8

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

12. (pupil p5) $(35 - 15) / (30 - 20) = 20 / 10 = 2.0 \text{ m/s}$. $35 / 30$ gives an average from the origin, not this section's speed.

13. (pupil p6) $(40 - 35) / (40 - 30) = 5 / 10 = 0.50 \text{ m/s}$.

14. (pupil p6) Total distance / total elapsed time = $40 / 50 = 0.80 \text{ m/s}$. The complete journey lasts 50 s, including its stops; excluding stops answers a different question.

15. (pupil p6) 20-30 s: this section has the greatest gradient. Graph height gives accumulated distance, not speed; the highest horizontal section is stationary.

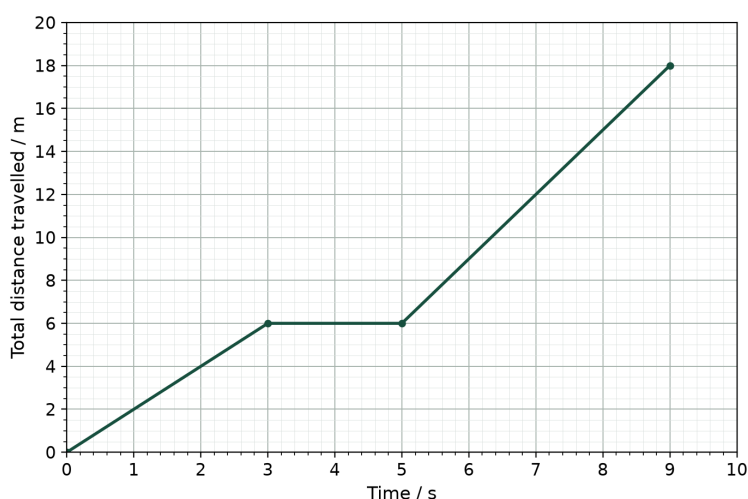
16. (pupil p6) Travelling west still adds to the total distance travelled. The vertical axis is accumulated distance, not position or signed displacement, so it increases during this movement.

17. (pupil p7) Time / s horizontally; total distance travelled / m vertically. Plot (0,0), (3,6), (5,6), (9,18), using the supplied consistent scales. Join consecutive points with straight segments. Use the supplied teacher graph to check plotting.

18. (pupil p7) Rest: 3-5 s. The fastest section is 5-9 s: $(18 - 6) / (9 - 5) = 12 / 4 = 3.0 \text{ m/s}$. The first section is $6 / 3 = 2 \text{ m/s}$.

19. (pupil p7) $18 / 9 = 2.0 \text{ m/s}$. Include the 2 s stop; do not take an unweighted mean of the three section speeds.

20. (pupil p8) Accept a correct answer plus the reason for the original error. For the all-correct route: height gives accumulated distance; gradient gives speed. Figure 1 is highest at 40-50 s, but horizontal there, so speed is zero; 20-30 s has the greatest gradient.



Correct graph for pupil question 17. Compare all four points, axis quantities/units and straight joining segments.

Exit and next-lesson follow-up - pupil page 8

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

21. (pupil p8) (a) 2-5 s. (b) First: $8 / 2 = 4.0$ m/s. Last: $(14 - 8) / (8 - 5) = 6 / 3 = 2.0$ m/s. The first section is faster. (c) $14 / 8 = 1.75$ m/s, including the stop.

Try again D - next lesson - pupil page 8

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

Rest: 2-4 s. Speeds: $6 / 2 = 3.0$ m/s and $(12 - 6) / (8 - 4) = 1.5$ m/s. Whole-journey average = $12 / 8 = 1.5$ m/s.

Collect and follow up

Collect all named booklets. Use the independent exit to record whether section gradients, stationary intervals and whole-journey averages are secure. Tell the usual teacher the specific error and who needs Try again D.

Source provenance - for the usual teacher

Pupil question	Original worksheet part / page
5	WS-05 Q1(c) / source p1
6	WS-05 Q1(d) / source p1
7	WS-05 Q2(a) / source p2
8	WS-05 Q2(b) / source p2
9	WS-05 Q2(c) / source p2
10	WS-05 Q2(d) / source p2
12	WS-05 Q2(e) / source p2
13	WS-05 Q2(f) / source p2
14	WS-05 Q2(g) / source p3
15	WS-05 Q2(h) / source p3
16	WS-05 Q2(i) / source p3

Selected practice is reformatted from the maintained PhysicsUK worksheet. Required context is included; unassigned parts are omitted.

Source worksheet | Maintained solutions | Revision notes

Pupil questions 17-19 adapt original practice question 3(a-c) in Motion Graphs, Speed and Acceleration. The coordinate data and complete solution are retained; a graph grid and scales are supplied.

Check 1: Entry

Question 1, Question 2, Question 3

Look for: Question 1: 3.0 m/s; question 2: 90 s; question 3: stationary, 0 m/s because distance is unchanged.

If secure: Continue to the reading and model on pupil page 2.

If: Question 1 multiplies distance and time or gives an incorrect unit; question 2 does not multiply minutes by 60.

Likely issue: Equation choice or the time unit is insecure.

Say: Speed is distance covered in one second, so divide distance by time. A minute contains 60 seconds.

Ask: For questions 1-2, what are 18 divided by 6, and 1.5 multiplied by 60?

Expect: 3.0 m/s and 90 s. Metres divided by seconds give m/s.

Next: Use the equation/units table on page 2. Direct Try again A on page 1 in the first 2 reading minutes, then check the fresh work.

Pupil page 2, equations and units; Try again A on page 1.

If: Question 3 calls the speed 12 m/s or says the object keeps moving.

Likely issue: Graph height has been confused with gradient.

Say: The height gives the total distance so far. During a horizontal section no extra distance is travelled, so speed is zero.

Ask: How much additional distance is travelled from 8 s to 14 s in question 3?

Expect: Zero metres, so the object is stationary at 0 m/s. Its existing 12 m total is not a speed.

Next: Use page 2, the horizontal-line rule. Direct Try again A on page 1 in reading time and require the stationary reason.

Pupil page 2, A graph section needs two changes; Try again A on page 1.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 2: Hinge

Question 4

Look for: B, with distance change 12 m and time interval 4 s, giving 3.0 m/s. A correct letter alone is insufficient.

If secure: Start questions 5-10. Require both endpoint differences to establish the method.

If: A uses 17 divided by 6.

Likely issue: The pupil divides final coordinates instead of using changes across this section.

Say: This section starts after zero time and distance. Use the distance added during it and the time it takes, not the final coordinates from the origin.

Ask: For question 4, what are 17 minus 5 and 6 minus 2?

Expect: 12 m and 4 s. Dividing gives 3.0 m/s, option B.

Next: Use the endpoint method on page 2, then Try again B on page 3 instead of questions 5-6. Check both changes. Pupil page 2, A graph section needs two changes; Try again B on page 3.

If: C reports only the distance change, or D divides time change by distance change.

Likely issue: The meaning or order of the gradient ratio is insecure.

Say: A speed needs distance per unit time. Divide metres by seconds; a distance change alone is not a speed.

Ask: The changes are 12 m and 4 s in question 4. Which division has unit m/s?

Expect: $12 / 4 = 3.0$ m/s. The reversed division has unit s/m.

Next: Use the speed equation and endpoint method on page 2. Complete Try again B on page 3 instead of questions 5-6.

Pupil page 2, speed and gradient; Try again B on page 3.

If: B is chosen without both changes or with incorrect working.

Likely issue: A correct choice may be a guess.

Say: The letter needs a checkable method. Write the two endpoint differences before dividing.

Ask: Explain how the two given points produce your speed in question 4.

Expect: Distance rises by 12 m in 4 s, so speed is 3.0 m/s. B follows from those changes.

Next: Ask for both endpoint differences. If insecure, use the page 2 method and Try again B instead of questions 5-6.

Pupil page 2, endpoint method; Try again B on page 3.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 3: Mid Practice

Question 11

Look for: Rest from 4-8 s and whole-journey average $12 / 8 = 1.5$ m/s, including the stop.

If secure: Continue questions 12-19, including the new graph on page 7.

If: Gives 3 m/s by using 4 s for the whole-journey average.

Likely issue: Stopped time has been removed from the denominator.

Say: Average speed over a whole journey uses the whole elapsed time. The clock still runs while the object is stopped.

Ask: In question 11, what is the total elapsed time from the beginning to the stated finish?

Expect: 8 s, including the 4 s stop. Average = $12 / 8 = 1.5$ m/s.

Next: Read the whole-journey rule on page 2. Direct Try again C on page 5 instead of questions 12-13, then continue 14-19.

Pupil page 2, Whole journeys and returns; Try again C on page 5.

If: Treats the constant 12 m height as a nonzero speed, or misses the rest interval.

Likely issue: Accumulated distance and speed are still being confused.

Say: The total stays at 12 m during 4-8 s. Staying at the same accumulated distance means no motion in that interval.

Ask: How much distance is added after 4 s in question 11, and what is the rest interval?

Expect: No distance is added; rest is 4-8 s. For the complete run, $12 / 8 = 1.5$ m/s.

Next: Use page 2, the horizontal-line rule and whole-journey definition. Complete Try again C instead of questions 12-13.

Pupil page 2, graph rules and whole-journey rule; Try again C on page 5.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 4: Exit

Question 21

Look for: Rest 2-5 s; moving speeds 4.0 and 2.0 m/s with the first faster; whole average 1.75 m/s.

If secure: Record the objectives demonstrated by the independent work, then identify any precise follow-up.

If: Uses the final coordinates for the last section, or chooses the highest section as fastest.

Likely issue: The endpoint-gradient or height-versus-speed distinction needs follow-up.

Say: Compare the changes during each section. The last stage starts at 8 m and 5 s, so its distance and time changes must both be subtracted.

Ask: In question 21, what distance and time are added during 5-8 s? Compare its speed with 0-2 s.

Expect: 6 m in 3 s gives 2.0 m/s; the first stage is 8 m in 2 s, or 4.0 m/s, so the first is faster.

Next: Next lesson, revisit the endpoint method and graph rules on page 2, then complete Try again D independently on page 8.

Pupil page 2, endpoint gradient; Try again D on page 8, next lesson only.

If: Misses the 2-5 s rest, excludes it from the average or averages the moving-stage speeds.

Likely issue: Whole elapsed time and stationary intervals need follow-up.

Say: The unchanged 8 m reading identifies a stop. For average speed, use the full 14 m and all 8 s; do not take an unweighted mean of stage speeds.

Ask: Which interval adds time but no distance in question 21? What division gives the whole average?

Expect: 2-5 s adds stopped time. Whole average = $14 / 8 = 1.75$ m/s.

Next: Next lesson, use the whole-journey rule on page 2 before Try again D on page 8. Keep that follow-up outside today's 60 minutes.

Pupil page 2, whole-journey rule; Try again D on page 8, next lesson only.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Specification and review

AQA 8463: 4.5.6.1.1, 4.5.6.1.2, 4.5.6.1.4 | AQA 8464: 6.5.4.1.1, 6.5.4.1.2, 6.5.4.1.4. Speed/time calculations, straight-line distance-time gradients, stationary intervals, graph construction and whole-journey average speed. Both courses and tiers use this selection. Tangents, velocity-time areas and practical completion are excluded.

PhysicsUK original cover lesson. Reviewed 2026-10-31. Timings estimated.