

# Covering teacher guide

## Acceleration and velocity-time graphs

### Start here / subject briefing

**Before this lesson:** Consolidation after velocity, acceleration, straight-line graphs and uniform-acceleration calculations have been taught. Both tiers follow the same selected route; no graph areas or tangents are assigned.

Velocity includes direction; acceleration measures its change per second. On a velocity-time plot height gives velocity and gradient gives acceleration. A falling line above zero is slowing positive-direction motion, not backwards motion. A flat nonzero line means moving with zero acceleration. For uniform forward motion,  $v^2 = u^2 + 2as$  gives squared speed, so take a square root.

### Words and symbols you will need

| Term                                | Plain-English meaning                                                                                             |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Velocity, u or v (m/s)              | Speed with direction; u is initial and v final in the equation.                                                   |
| Acceleration, a (m/s <sup>2</sup> ) | Change in velocity each second; can be positive, negative or zero.                                                |
| Gradient / elapsed time             | Velocity change divided by the time change between the same two points.                                           |
| Displacement, s (m)                 | Distance along the chosen straight-line direction for these forward tests.                                        |
| Uniform / v <sup>2</sup>            | Uniform acceleration stays constant. v <sup>2</sup> is squared velocity and needs a square root to recover speed. |

### Help pupils choose a method

1. Read axis quantity and sign convention; use velocity to identify direction.
2. For acceleration use both endpoint differences, later minus earlier, and divide by elapsed time.
3. For uniform forward u,a,s data, calculate  $v^2 = u^2 + 2as$ , then take the positive square root. Check units and plausibility.

### Use the supplied model - pupil page 2

Use pupil page 2. The first test gains 12 m/s in 6 s, so acceleration is 2 m/s<sup>2</sup>. The separate second test gives squared speed 16, so final speed is 4 m/s; the intermediate 16 is not the speed.

Acceleration =  $(16 - 4.0)/6.0 = 2.0 \text{ m/s}^2$ . Separate test:  $v^2 = u^2 + 2as = 2.0^2 + 2 \times 1.5 \times 4.0 = 16 \text{ m}^2/\text{s}^2$ . Final speed  $v = \sqrt{16} = 4.0 \text{ m/s}$ . Take the square root after calculating v<sup>2</sup>.

### If pupils are still stuck

Use the matching Say/Ask/Expect and named independent retry in its replacement time. If still insecure, help write the two differences or the v<sup>2</sup> substitution with labels, then record the specific step needing follow-up. Keep next-lesson support outside today's 60 minutes.

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

# Run the lesson from this page

## Acceleration and velocity-time graphs

Print the complete 8-page pupil booklet, one per pupil, stapled in order. Double-sided printing is fine.

Read teacher page 1, then use the timed run sheet on page 2. Keep the 10-page teacher guide separate from pupil copies.

Pupils need pens, a ruler and a calculator. Reading, data and figures are supplied. No login, pupil devices or practical apparatus are required.

| Min   | Pupil page / Q | Read aloud / check                                                       | Next action and answer key                                                                                        |
|-------|----------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| 0-5   | 1 / 1-3        | Start from memory; check at 5 minutes.                                   | If insecure A uses the first 2 reading minutes. Answers: teacher page 3. Coaching: page 7.                        |
| 5-15  | 2 / reading    | Read quantities and the two models. Explain why a square root is needed. | Check A if used; then continue reading.                                                                           |
| 15-20 | 3 / 4          | Choose a letter with both changes and a motion reason; stop.             | If insecure B replaces 5-6. The remaining source questions use 0-20 s. Answers: teacher page 3. Coaching: page 8. |
| 20-30 | 4 / 5-9        | Complete the graph, then read velocities and gradients.                  | If B was used leave 5-6 blank. Require signed acceleration. Answers: teacher page 4.                              |
| 30-33 | 5 / 10         | Complete question 10 independently and pause.                            | If insecure C replaces 11-12. Answers: teacher page 4. Coaching: page 9.                                          |
| 33-45 | 5-7 / 11-16    | Finish graph explanations, then apply both equations.                    | If C was used leave 11-12 blank; complete 13-16. Final speed needs square root. Answers: teacher page 5.          |
| 45-55 | 8 / 17         | Correct practice in a different colour and explain a correction.         | Share only practice answers. Refer to the checked teacher graph for Q5. Answers: teacher page 5.                  |
| 55-60 | 8 / 18         | Cover earlier pages; complete question 18 independently.                 | Collect booklets and check 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 two note applications. A uses reading time; B replaces 5-6; C replaces 11-12; 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)  $(10-4.0)/3.0 = +2.0 \text{ m/s}^2$ .
2. (pupil p1) Acceleration =  $0 \text{ m/s}^2$  because velocity is unchanged. It is moving, not stationary.
3. (pupil p1)  $v =$  positive square root of 49 =  $7.0 \text{ m/s}$ . 49 is the squared speed.
4. (pupil p3) A.  $a=(2.0-8.0)/(6.0-2.0)=-6/4=-1.5 \text{ m/s}^2$ . Velocity stays positive, so the object travels east while slowing.

### Try again A - pupil page 1

Only if directed. Use the first 2 reading minutes, then continue on page 2.

(a)  $(14-2)/4=3 \text{ m/s}^2$ . (b)  $0 \text{ m/s}^2$ , still moving. (c)  $\sqrt{81}=9 \text{ m/s}$ .

### Try again B - pupil page 3

Only if directed. Complete this instead of questions 5-6, then answer questions 7-9 on page 4.

$a=(2-10)/(7-3)=-8/4=-2 \text{ m/s}^2$ . Positive velocity means moving east; it slows because velocity decreases.

## First graph practice and mid-check

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

**5. (pupil p4)** Horizontal line from (20 s, 1.0 m/s) to (24 s, 1.0 m/s), as in the supplied teacher graph.

**6. (pupil p4)** 2.0 m/s east. The velocity is positive and constant during 4-8 s.

**7. (pupil p4)**  $a = (2.0-0)/(4.0-0) = +0.50 \text{ m/s}^2$ .

**8. (pupil p4)**  $a = (0-2.0)/(12-8) = -0.50 \text{ m/s}^2$ . The acceleration points west while the robot slows travelling east. Deceleration magnitude is  $0.50 \text{ m/s}^2$ , but the signed answer is negative.

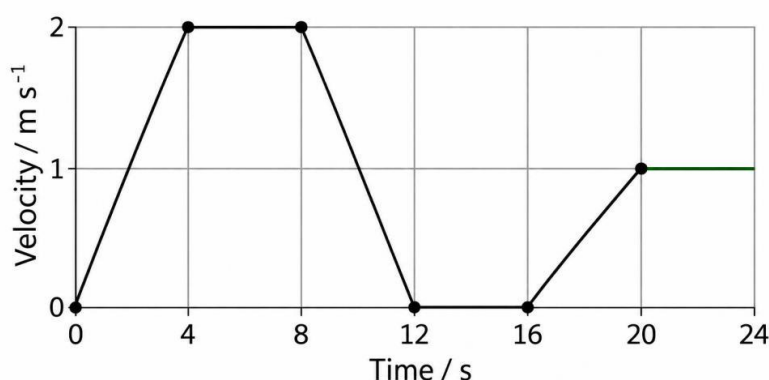
**9. (pupil p4)** Velocity stays constant at 2.0 m/s east. Acceleration is zero because velocity is unchanged; the robot is moving, not stationary.

**10. (pupil p5)** Increasing section:  $(9.0-3.0)/4.0 = +1.5 \text{ m/s}^2$ . Flat section: acceleration  $0 \text{ m/s}^2$ ; cart still moves at  $+9.0 \text{ m/s}$ .

## Try again C - pupil page 5

Only if directed. Complete this instead of questions 11-12, then continue with questions 13-16.

Increasing:  $(11-5)/3 = 2 \text{ m/s}^2$ . Constant:  $0 \text{ m/s}^2$ , still moving at  $11 \text{ m/s}$ .



Completed Figure 2 for question 5. The final section is horizontal at  $+1.0 \text{ m/s}$  during 20-24 s.

## Later graph work, equations and review

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

**11. (pupil p5)** 12-16 s, when velocity is zero throughout.

**12. (pupil p6)** Velocity increases linearly from 0 to 1.0 m/s east. Acceleration is constant and positive because gradient is constant:  $(1.0-0)/(20-16) = +0.25 \text{ m/s}^2$ .

**13. (pupil p6)** The robot has a constant acceleration of  $+0.50 \text{ m/s}^2$ ; its velocity increases linearly from 0 to 2.0 m/s east. The robot accelerates; its velocity increases.

**14. (pupil p6)** Velocity remains positive until reaching zero at 12 s, so motion is east, slowing. The falling line shows negative acceleration, not negative velocity. Its sign above/below the time axis establishes direction.

**15. (pupil p7)**  $a=(v-u)/t=(15-3.0)/6.0=+2.0 \text{ m/s}^2$ .

**16. (pupil p7)**  $v^2=u^2+2as=1.0^2+2\times2.0\times6.0=25 \text{ m}^2/\text{s}^2$ .  $v=\sqrt{25}=5.0 \text{ m/s}$ , the positive root for the stated forward motion.

**17. (pupil p8)** Accept a corrected answer with the reason for the error. All-correct route: in 8-12 s velocity is positive until the object stops, so it moves east; its falling velocity gives negative acceleration. The sign of velocity sets motion direction, not the sign of gradient.

## Independent exit and next-lesson follow-up

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

**18. (pupil p8)** (a)  $a = (4.0 - 12) / (5.0 - 1.0) = -8/4 = -2.0 \text{ m/s}^2$ ; moving east while slowing. (b)  $v^2 = 2^2 + 2 \times 2 \times 8 = 36 \text{ m}^2/\text{s}^2$ ;  $v = 6.0 \text{ m/s}$ . (c) Acceleration  $0 \text{ m/s}^2$ ; it still moves at  $4.0 \text{ m/s}$  east.

### Try again D - next lesson - pupil page 8

Leave this today. Your usual teacher may direct it next lesson.

Gradient  $= (5 - 15) / (7 - 2) = -2 \text{ m/s}^2$ ; moving east and slowing. Separate cart:  $v^2 = 1 + 2 \times 1 \times 12 = 25$ , so  $v = 5 \text{ m/s}$ . At constant velocity  $3 \text{ m/s}$  acceleration is zero, but the cart still moves.

### Collect and follow up

Collect every named booklet with working and graph completion. Use question 18 to identify endpoint/sign, direction, square-root or flat-line errors, then report the exact step and who needs Try again D.

### Source provenance - for the usual teacher

| Pupil question | Original worksheet part / page |
|----------------|--------------------------------|
| 5              | WS-05 Q3(a) / source p3        |
| 6              | WS-05 Q3(b) / source p3        |
| 7              | WS-05 Q3(c) / source p3        |
| 8              | WS-05 Q3(d) / source p4        |
| 9              | WS-05 Q3(e) / source p4        |
| 11             | WS-05 Q3(f) / source p4        |
| 12             | WS-05 Q3(g) / source p4        |
| 13             | WS-05 Q3(h) / source p4        |
| 14             | WS-05 Q3(i) / source p4        |

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

Source worksheet | Maintained solutions | Revision notes

Q15 and Q16 adapt the note's original practice 1 and 5 with full data and complete solutions retained. The two supplied models come from the selected note sections.

## Check 1: Entry

### Question 1, Question 2, Question 3

**Look for:** Q1  $+2.0 \text{ m/s}^2$ ; Q2 zero acceleration while moving; Q3 speed  $7.0 \text{ m/s}$ .

**If secure:** Continue to page 2 reading and models.

**If: Uses 10/3 rather than  $(10-4)/3$ , or says constant velocity means stationary.**

**Likely issue:** Velocity and change in velocity are confused.

**Say:** Acceleration depends on the change, not the final velocity. If velocity stays nonzero and constant, the object still moves but does not accelerate.

**Ask:** For question 1 what is 10-4? In question 2 does  $6.0 \text{ m/s}$  describe rest?

**Expect:** Change  $6.0 \text{ m/s}$  gives  $2.0 \text{ m/s}^2$ ;  $6.0 \text{ m/s}$  means moving, with acceleration zero.

**Next:** Use the relevant method on page 2; complete Try again A on page 1 during the first 2 reading minutes.

Pupil page 2, acceleration and flat-line rules.

**If: Reports  $49 \text{ m/s}$  as the answer to question 3.**

**Likely issue:** Squared speed has not been converted to speed.

**Say:**  $v^2$  is speed multiplied by itself. Use the positive square root for the speed asked here.

**Ask:** In question 3, which positive number multiplied by itself gives 49?

**Expect:** 7, so final speed is  $7.0 \text{ m/s}$ , not  $49 \text{ m/s}$ .

**Next:** Use the relevant method on page 2; complete Try again A on page 1 during the first 2 reading minutes.

Pupil page 2, uniform-acceleration method.

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:** A, with velocity change  $-6 \text{ m/s}$ , elapsed time  $4 \text{ s}$  and acceleration  $-1.5 \text{ m/s}^2$ ; motion east and slowing.

**If secure:** Begin questions 5-9. Require both endpoint differences and a separate direction reason.

**If: B uses final coordinates 2/6.**

**Likely issue:** The relevant graph interval has not been isolated.

**Say:** Subtract the two velocities and the two times. This section does not start at the origin.

**Ask:** In question 4, what are 2-8 and 6-2?

**Expect:**  $-6 \text{ m/s}$  and  $4 \text{ s}$ , giving  $-1.5 \text{ m/s}^2$ .

**Next:** Use page 2 endpoint/sign methods; complete Try again B on page 3 instead of questions 5-6.

Pupil page 2, graph-section method.

**If: C calls the motion west because acceleration is negative.**

**Likely issue:** Acceleration direction has been confused with travel direction.

**Say:** The velocity values remain positive, so travel is east. Their decrease gives negative acceleration and slowing.

**Ask:** In question 4 are the velocities above or below zero throughout the section?

**Expect:** Above zero: eastward motion while slowing.

**Next:** Use page 2 endpoint/sign methods; complete Try again B on page 3 instead of questions 5-6.

Pupil page 2, motion-direction rule.

**If: D reverses the velocity difference, or A is chosen without working.**

**Likely issue:** The sign is lost or the correct letter may be a guess.

**Say:** Keep the same chronological order in both differences: later minus earlier. Then describe motion using velocity, not gradient.

**Ask:** Show both differences and explain east/slowing for question 4.

**Expect:**  $(2-8)/(6-2) = -1.5 \text{ m/s}^2$ ; positive velocity means east, decreasing velocity means slowing.

**Next:** Use page 2 endpoint/sign methods; complete Try again B on page 3 instead of questions 5-6.

Pupil page 2, endpoint and sign rules.

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 10

**Look for:** Q10 increasing acceleration  $1.5 \text{ m/s}^2$ ; flat acceleration zero while moving at  $9.0 \text{ m/s}$ .

**If secure:** Continue 11-16 with the same quantity distinctions.

**If: Uses 9/4 or an incorrect velocity change for the increasing stage.**

**Likely issue:** Final velocity has replaced change in velocity.

**Say:** The first  $3 \text{ m/s}$  was already present. Only the additional  $6 \text{ m/s}$  is gained during these 4 seconds.

**Ask:** In question 10, how much is added to  $3 \text{ m/s}$  to reach  $9 \text{ m/s}$ ?

**Expect:**  $6 \text{ m/s}$  added in  $4 \text{ s}$ , so acceleration is  $1.5 \text{ m/s}^2$ .

**Next:** Use page 2 acceleration/flat-line methods. Complete Try again C on page 5 instead of questions 11-12.

Pupil page 2,  $a = \text{change in velocity} / \text{time}$ .

**If: Calls the flat section stationary or gives acceleration  $9 \text{ m/s}^2$ .**

**Likely issue:** Graph height and gradient are confused.

**Say:** Height gives velocity; gradient gives acceleration. At height  $9 \text{ m/s}$  with no slope, the cart moves steadily with zero acceleration.

**Ask:** In question 10, does velocity change during the flat section, and is its velocity zero?

**Expect:** It does not change, so acceleration is zero; velocity is  $9 \text{ m/s}$ , so it is moving.

**Next:** Use page 2 acceleration/flat-line methods. Complete Try again C on page 5 instead of questions 11-12.

Pupil page 2, velocity versus acceleration.

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 18

**Look for:** Q18 gradient  $-2.0 \text{ m/s}^2$  with eastward slowing; separate final speed  $6.0 \text{ m/s}$ ; constant  $4 \text{ m/s}$  gives zero acceleration while moving.

**If secure:** Record independently secure gradient, motion-description and equation methods.

**If: Wrong endpoint gradient/sign or describes westward travel in part (a).**

**Likely issue:** Endpoint changes or direction versus acceleration needs follow-up.

**Say:** Use later minus earlier for velocity and time separately. Positive velocity still indicates eastward travel while it decreases.

**Ask:** For question 18(a), what are 4-12 and 5-1? Are both velocities positive?

**Expect:**  $-8 \text{ m/s}$  in  $4 \text{ s}$  gives  $-2.0 \text{ m/s}^2$ . Both velocities are positive, so travel is east, slowing.

**Next:** Next lesson revisit the corresponding page 2 methods, then complete Try again D independently on page 8. Pupil page 2, endpoint and direction methods.

**If: Reports  $36 \text{ m/s}$  in (b), or calls the flat  $4 \text{ m/s}$  stage stationary.**

**Likely issue:** Squared speed or height versus gradient remains insecure.

**Say:** The calculation in (b) gives  $v^2$ ; take its square root. A nonzero flat velocity is steady motion, not rest.

**Ask:** For question 18, what is  $\sqrt{36}$ , and does a velocity fixed at  $4 \text{ m/s}$  change or become zero?

**Expect:** Final speed  $6.0 \text{ m/s}$ . Fixed  $4 \text{ m/s}$  has zero acceleration but is still moving.

**Next:** Next lesson revisit the corresponding page 2 methods, then complete Try again D independently on page 8. Pupil page 2, squared-speed and flat-line methods.

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: 4.5.6.1.3, 4.5.6.1.5 | AQA 8464: 6.5.4.1.3, 6.5.4.1.5. Both courses and tiers: velocity/direction, straight velocity-time gradients, descriptions and the uniform-acceleration equation. No velocity-time areas, distance-time tangents, circular-motion or terminal-velocity/force extensions are assigned.

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