physics UK
Smarter practice. Stronger understanding

SOLUTIONS
ATTEMPT | CHECK | CORRECT | IMPROVE

Linear motion 1 solutions

AQA AS 7407 and first-year A Level 7408 | OCR A AS H156 and A Level H556

Matching solutions and teaching prompts for the class review

Specification points covered

AQA 7407 / 7408: 3.4.1.3 selected content — signed motion quantities, uniform-acceleration equations and free fall. Graph analysis and the free-fall practical are covered in separate worksheets.
OCR A H156 / H556: 3.1.1(a); 3.1.2(a)(i), (b)(i), (c) — kinematics, constant-acceleration motion, free fall and stopping distance.

Teaching focus
40 marks. Retain two short routine starters, then use the track constraints, stopping checks and calibration evidence to apply first-year mechanics.
Award each bracketed solution point up to the question total. Accept equivalent methods, consistent consequential numerical work and appropriate rounding. Retained one-result calculations earn one mark per requested result; do not require a particular equation layout unless stated.

Studio checks

1. A trolley has initial velocity 4.0 m s^{-1} and accelerates at 1.5 m s^{-2} for 6.0 s. Calculate its final velocity. [1 mark]

Answer / mark points: v = u + at = 4.0 + (1.5 x 6.0) = 13 m s^{-1}.

Teacher prompt / common error: One direct substitution: credit a correct final velocity with unit.

2. A test cart has initial velocity 18 m s^{-1} and acceleration -2.0 m s^{-2} for 4.0 s. Calculate its final velocity. [1 mark]

Answer / mark points: v = u + at = 18 + (-2.0 x 4.0) = 10 m s^{-1}.

Teacher prompt / common error: The negative acceleration reduces a still-positive velocity; it does not produce a negative speed.

3. A camera glider starts from rest and accelerates at 0.60 m s^{-2} for 10 s. The unobstructed studio track is 28 m long. Calculate its displacement and decide whether the whole accelerating run fits on the track. [2 marks]

Answer / mark points: $s = \frac{1}{2}at^2 = \frac{1}{2} \times 0.60 \times 10^2 = 30$ m. [1] This exceeds 28 m, so the complete run does not fit; the glider reaches the end before 10 s. [1]

Teacher prompt / common error: The track length is a constraint, not the displacement to substitute into the first calculation.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

4. A camera trolley changes velocity uniformly from 3.0 m s^{-1} to 11 m s^{-1} in 4.0 s. The actor marker is 30 m ahead of its initial position. Calculate the trolley displacement and state whether it has reached the marker after 4.0 s. [2 marks]

Answer / mark points: $s = \frac{1}{2}(u + v)t = \frac{1}{2}(3.0 + 11) \times 4.0 = 28$ m. [1] It has not reached the marker; it is 2 m short. [1]

Teacher prompt / common error: Average velocity equals (u + v)/2 here because acceleration is constant.

5. A dolly enters a 24 m shot section at 5.0 m s^{-1} and accelerates uniformly at 2.0 m s^{-2}. The camera stabiliser must not exceed a speed of 10 m s^{-1}. Calculate its speed at the end and decide whether the stabiliser limit is met. [2 marks]

Answer / mark points: $v^2 = u^2 + 2as = 5.0^2 + 2 \times 2.0 \times 24 = 121$, so $v = 11$ m s^{-1}. [1] The limit is not met because $11 > 10$ m s^{-1}. [1]

Teacher prompt / common error: The positive root applies: the dolly continues in the initial direction.

6. A camera dolly starts from rest and accelerates east at 0.80 m s^{-2} for 7.5 s. Calculate (i) its final velocity and (ii) its displacement. [2 marks]

Answer / mark points: (i) $v = 0 + (0.80 \times 7.5) = 6.0$ m s^{-1} east. (ii) $s = 0.5 \times 0.80 \times 7.5^2 = 22.5$ m east.

Teacher prompt / common error: Keep the east direction in the final answers where pupils have used a signed convention.

7. For a second shot, the dolly already moves east at 2.5 m s^{-1}. It accelerates east at 1.2 m s^{-2} for 6.0 s. Calculate (i) its final velocity and (ii) its displacement. [2 marks]

Answer / mark points: (i) $v = 2.5 + (1.2 \times 6.0) = 9.7$ m s^{-1} east. (ii) $s = (2.5 \times 6.0) + [0.5 \times 1.2 \times 6.0^2] = 36.6$ m east.

Teacher prompt / common error: Check that pupils include both the initial-velocity displacement and the acceleration displacement.

8. The dolly approaches a stop marker at 12 m s^{-1} and has constant acceleration -3.0 m s^{-2} for 3.0 s. Calculate (i) its final velocity and (ii) its displacement in this interval. [2 marks]

Answer / mark points: (i) $v = 12 + (-3.0 \times 3.0) = 3.0$ m s^{-1}. (ii) $s = (12 \times 3.0) + [0.5 \times (-3.0) \times 3.0^2] = 22.5$ m.

Teacher prompt / common error: The cart has not stopped after 3.0 s: its final velocity is still +3.0 m s^{-1}.

9. In Question 8, explain why -3.0 m s^{-2} does not mean that the dolly has negative speed. [1 mark]

Answer / mark points: The negative sign gives the direction of acceleration. The dolly is moving east but its velocity decreases, so its speed is positive and decreases.

Teacher prompt / common error: Use speed for a magnitude. A signed quantity here is velocity or acceleration.

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk

10. A battery-powered crate mover has initial velocity 2.0 m s^{-1}. Its velocity becomes 14 m s^{-1} after moving 48 m with constant acceleration. Show that its acceleration is 2.0 m s^{-2}. [2 marks]

Answer / mark points: $v^2 = u^2 + 2as$, so $a = (v^2 - u^2) / (2s) = (14^2 - 2.0^2) / (2 \times 48) = 2.0$ m s^{-2}.
Teacher prompt / common error: The mark split is sensible equation rearrangement, then correct substitution and unit.

Other constant-acceleration contexts

11. A rail-mounted lift carrier travels at 8.0 m s^{-1} and slows uniformly to rest with acceleration -1.6 m s^{-2}. Calculate (i) the time taken to stop and (ii) the displacement while stopping. [2 marks]

Answer / mark points: (i) $t = (v - u) / a = (0 - 8.0) / (-1.6) = 5.0$ s. (ii) $s = 0.5(8.0 + 0)(5.0) = 20$ m.
Teacher prompt / common error: Stopping distance is positive even though the acceleration is negative.

12. Two test runs each last 4.0 s. Run A starts from rest and has acceleration 1.0 m s^{-2}. Run B starts at 2.0 m s^{-1} and has acceleration 0.50 m s^{-2}. Calculate both final velocities and state whether either run has the greater final speed. [3 marks]

Answer / mark points: Run A: $v = 0 + (1.0 \times 4.0) = 4.0$ m s^{-1}. Run B: $v = 2.0 + (0.50 \times 4.0) = 4.0$ m s^{-1}. They have the same final speed.
Teacher prompt / common error: This is comparison practice, not an overtaking question. Both final speeds are equal.

13. A small tool falls from rest for 1.2 s. Air resistance is negligible. Use g = 9.81 m s^{-2} to calculate (i) its speed and (ii) the distance it falls. [2 marks]

Answer / mark points: (i) $v = 0 + (9.81 \times 1.2) = 11.8$ m s^{-1}. (ii) $s = 0.5 \times 9.81 \times 1.2^2 = 7.1$ m.
Teacher prompt / common error: State the negligible-air-resistance assumption allows constant acceleration g.

14. The tool in Question 13 is brought to rest uniformly in 0.30 s by a safety catch. Take downward as positive. Calculate its acceleration and state the direction of this acceleration. [2 marks]

Answer / mark points: $a = (v - u) / t = (0 - 11.8) / 0.30 = -39$ m s^{-2} (2 s.f.). The acceleration is upward, opposite to the positive downward direction.
Teacher prompt / common error: With downward positive, an upward acceleration must be negative.

15. A pupil writes $s = ut + at^2$ for a trolley moving with constant acceleration. Identify the error in the equation. [1 mark]

Answer / mark points: The acceleration term must be $0.5at^2$, not at^2.
Teacher prompt / common error: The missing factor is 0.5; do not award for merely writing a different SUVAT equation.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

End of shot checks

16. At the end of a shot the dolly travels east at 6.0 m s^{-1}. Its controller waits 0.40 s at this constant velocity before braking with constant acceleration −1.5 m s^{-2} until rest. There is 14.0 m of clear track ahead. Calculate the braking time and the total stopping distance, including the controller delay. Decide whether the dolly stops within the clear track. [4 marks]

Answer / mark points: Braking time $t = (0 - 6.0)/(-1.5) = 4.0$ s. [1] Delay distance = 6.0 × 0.40 = 2.4 m. [1] Braking distance = $(0^2 - 6.0^2)/(2 \times -1.5) = 12$ m, so total stopping distance = 14.4 m. [1] It does not stop within 14.0 m; it overshoots by 0.4 m. [1]

Teacher prompt / common error: The constant-velocity delay and constant-acceleration braking are separate stages. Total elapsed stopping time would be 4.4 s, not the braking time requested.

17. For the same 6.0 m s^{-1} initial velocity, 0.40 s controller delay and 14.0 m clear track, determine the magnitude of constant braking acceleration that would stop the dolly exactly at the boundary. The two available presets have magnitudes 1.5 m s^{-2} and 1.8 m s^{-2}. Which preset should be selected to stop within the clear track? [3 marks]

Answer / mark points: Available braking distance = 14.0 − 2.4 = 11.6 m. Using $v^2 = u^2 + 2as$ gives $|a| = 6.0^2/(2 \times 11.6)$. [1] Threshold magnitude = 1.5517… m s^{-2}, approximately 1.55 m s^{-2}. [1] Select 1.8 m s^{-2}: it is above the threshold; 1.5 m s^{-2} is insufficient. [1] At 1.8 m s^{-2} the total distance is 12.4 m.

Teacher prompt / common error: A larger braking-acceleration magnitude means a shorter braking distance. Keep guard digits for a boundary decision; do not round down then treat the rounded value as an exact safe minimum.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

Checking the calibration

18. In a separate calibration run, the dolly starts from rest and moves 18.0 m in 6.00 s with constant acceleration. Determine its acceleration and final speed. Explain why the value 18.0/6.00 = 3.00 m s^{-1} is not its final speed. [3 marks]

Answer / mark points: $a = 2s/t^2 = 2 \times 18.0/6.00^2 = 1.00$ m s^{-2}. [1] $v = at = 6.00$ m s^{-1}. [1] 3.00 m s^{-1} is the average velocity over the interval; velocity increases from zero, so the final speed is larger. [1]

Teacher prompt / common error: Do not use distance divided by elapsed time as the final speed of an accelerating object.

19. During a warm-battery check, measured eastward velocities at 0 s, 1 s, 2 s and 3 s are 0 m s^{-1}, 1.0 m s^{-1}, 3.0 m s^{-1} and 6.0 m s^{-1}. Calculate the average acceleration in the first and last one-second intervals. Explain whether one constant-acceleration SUVAT calculation is justified for the whole three seconds. [3 marks]

Answer / mark points: First interval: $a = (1.0 - 0)/1 = 1.0$ m s^{-2}. [1] Last interval: $a = (6.0 - 3.0)/1 = 3.0$ m s^{-2}. [1] The interval accelerations differ, so the evidence does not support constant acceleration; one constant-acceleration calculation is not justified for the whole run. [1]

Teacher prompt / common error: These are average accelerations over intervals. Do not claim the measurements prove a particular continuous acceleration curve between them.

Closing review

Ask pupils to say which quantities are signed before they substitute values.
Keep the distinction explicit: velocity and acceleration can be positive or negative; speed is a magnitude.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk