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SOLUTIONS
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OCR A A Level Linear Motion 1 solutions

Matching solutions and teaching prompts for the class review

Specification points covered

• 3.1.1(a) Define and use displacement, instantaneous speed, average speed, velocity and acceleration.
• 3.1.2(a)(i) Apply equations of motion for constant acceleration in a straight line, including motion in a uniform gravitational field without air resistance.

Teaching focus
This first linear-motion sheet is deliberately limited to direct substitutions and single-body constant-acceleration scenarios. Save graph interpretation, overtaking and equal-distance/time comparisons for Linear Motion 2.

Quick substitution practice

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: $v = u + at = 4.0 + (1.5 \times 6.0) = 13$ 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: $v = u + at = 18 + (-2.0 \times 4.0) = 10$ m s^{-1}.

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

3. A glider starts from rest and accelerates at 0.60 m s^{-2} for 10 s. Calculate its displacement. [1 mark]

Answer / mark points: $s = ut + 0.5at^2 = 0 + 0.5 \times 0.60 \times 10^2 = 30$ m.

Teacher prompt / common error: Starting from rest means u = 0, not that acceleration is zero.

4. A trolley changes velocity uniformly from 3.0 m s^{-1} to 11 m s^{-1} in 4.0 s. Calculate its displacement. [1 mark]

Answer / mark points: $s = 0.5(u + v)t = 0.5(3.0 + 11)(4.0) = 28$ m.

Teacher prompt / common error: This equation uses average velocity for constant acceleration.

From substitution to worded scenarios

5. An object has initial velocity 5.0 m s^{-1} and acceleration 2.0 m s^{-2} over a displacement of 24 m. Calculate its final velocity. [1 mark]

Answer / mark points: $v^2 = u^2 + 2as = 5.0^2 + 2(2.0)(24) = 121$; v = 11 m s^{-1}.
Teacher prompt / common error: Take the positive root because the stated initial motion is in the positive 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 x 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 x 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 x 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.

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 x 4.0) = 4.0 m s^{-1}. Run B: v = 2.0 + (0.50 x 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 x 1.2) = 11.8 m s^{-1}. (ii) s = 0.5 x 9.81 x 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.

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.