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# OCR A A Level Linear Motion 2 solutions

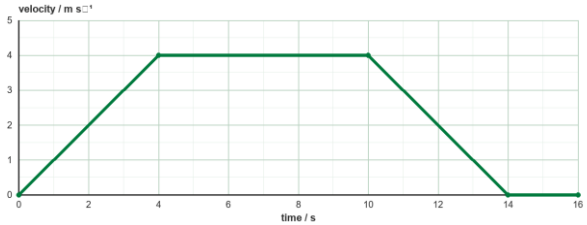
*Matching solutions and teaching prompts for the class review*

## Specification points covered

• 3.1.1(a) Define and use displacement, instantaneous speed, average speed, velocity and acceleration.
• 3.1.1(b) Interpret graphical representations of displacement, speed, velocity and acceleration.
• 3.1.1(c) Use displacement-time graphs to determine velocity as the gradient.
• 3.1.1(d) Use velocity-time graphs to determine acceleration as the gradient and displacement as the area under the graph, including estimation for non-linear graphs.

**Teaching focus**
This advanced sheet emphasises graph language, gradients, area under a velocity-time graph, and comparing two journeys.
Insist on precise wording: velocity or displacement can increase, decrease or stay the same; acceleration describes the rate of change of velocity.

## 1. Velocity-time graph: delivery cart




**1. State the velocity of the delivery cart at t = 2.0 s. [1 mark]**

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| **Answer / mark points:** 2.0 m $s^{-1}$. |
| **Teacher prompt / common error:** Read the vertical axis at the stated time; no calculation is needed. |

**2. From t = 0 to t = 4.0 s, describe the cart's velocity and acceleration. Use precise scientific language. [2 marks]**

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| **Answer / mark points:** The velocity increases linearly from 0 to +4.0 m $s^{-1}$. The acceleration stays constant and is positive. |
| **Teacher prompt / common error:** Do not accept 'the velocity accelerates'. Velocity increases; acceleration is constant and positive. |

**3. State the time at which the cart starts to slow down. [1 mark]**

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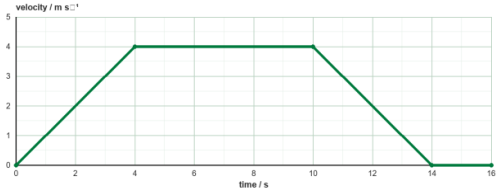
| **Answer / mark points:** t = 10 s. |
| **Teacher prompt / common error:** The cart starts to slow at the change from horizontal to a negative gradient. |

## 1. Velocity-time graph: delivery cart continued




**4. Calculate the acceleration of the cart from t = 10 s to t = 14 s. [1 mark]**

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| **Answer / mark points:** a = delta v / delta t = (0 - 4.0) / (14 - 10) = -1.0 m $s^{-2}$. |
| **Teacher prompt / common error:** A negative gradient on a velocity-time graph means negative acceleration. |

**5. Calculate the displacement of the cart from t = 0 to t = 14 s. [3 marks]**

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| **Answer / mark points:** Displacement = area under the velocity-time graph = 0.5(4)(4) + (6)(4) + 0.5(4)(4) = 8 + 24 + 8 = 40 m. |
| **Teacher prompt / common error:** Credit the three separate areas, then their sum. The area under a velocity-time graph is displacement. |

**6. State the displacement of the cart from t = 14 s to t = 16 s. [1 mark]**

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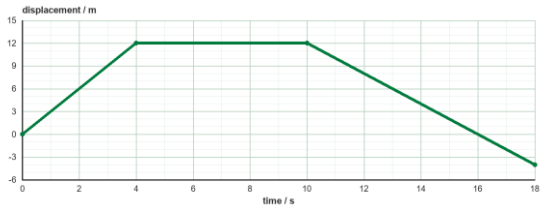
| **Answer / mark points:** 0 m. The cart is stationary, so its velocity and displacement in this interval are zero. |
| **Teacher prompt / common error:** Stationary means v = 0, so the area and hence displacement are zero. |

## 2. Displacement-time graph: safety trolley




**7. Use the graph to calculate the velocity of the safety trolley from t = 0 to t = 4.0 s. [1 mark]**

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| **Answer / mark points:** velocity = gradient = (12 - 0) / (4.0 - 0) = +3.0 m $s^{-1}$. |
| **Teacher prompt / common error:** On a displacement-time graph, velocity is the gradient, not the area. |

**8. From t = 4.0 s to t = 10 s, describe the trolley's displacement and velocity. [2 marks]**

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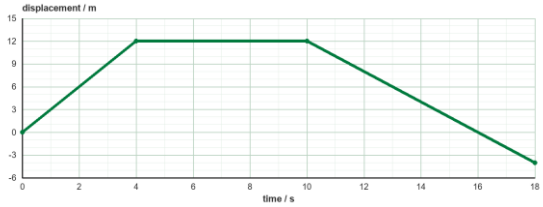
| **Answer / mark points:** The displacement stays the same at +12 m. The gradient is zero, so the trolley is stationary and its velocity is zero. |
| **Teacher prompt / common error:** A horizontal displacement-time line has zero gradient: the object is stationary. |

## 2. Displacement-time graph: safety trolley continued




**9. Use the graph to calculate the velocity of the safety trolley from t = 10 s to t = 18 s. [1 mark]**

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| **Answer / mark points:** velocity = gradient = (-4 - 12) / (18 - 10) = -16 / 8 = -2.0 m $s^{-1}$. |
| **Teacher prompt / common error:** The negative value is a velocity, so it encodes direction as well as magnitude. |

**10. From t = 10 s to t = 18 s, describe the trolley's motion. Include the direction of travel. [2 marks]**

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| **Answer / mark points:** The displacement decreases linearly. The trolley moves in the negative direction at constant velocity (-2.0 m $s^{-1}$). |
| **Teacher prompt / common error:** The required language is 'displacement decreases linearly' and 'constant negative velocity'. |

**11. Calculate the total distance travelled by the trolley from t = 0 to t = 18 s. [2 marks]**

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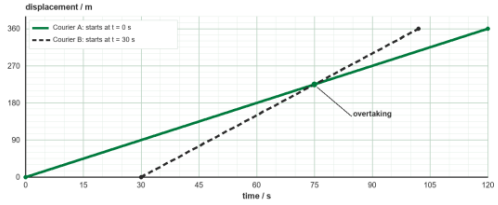
| **Answer / mark points:** Total distance = 12 m + 16 m = 28 m. The second part is a distance of 16 m even though the displacement change is -16 m. |
| **Teacher prompt / common error:** Distance adds magnitudes: it is not the final displacement (-4 m). |

## 3. Comparing journeys: overtaking and equal distance




**12. At t = 30 s, calculate how far ahead of Courier B Courier A is. [1 mark]**

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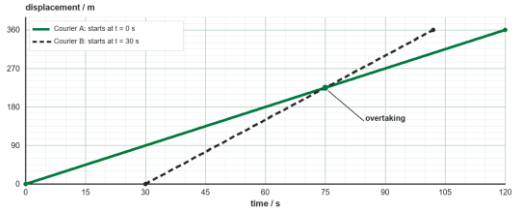
| **Answer / mark points:** Courier A has travelled (3.0 x 30) = 90 m. Courier B is at the gate, so A is 90 m ahead. |
| **Teacher prompt / common error:** This is a direct use of Courier A's constant gradient before Courier B starts. |

## 3. Comparing journeys: overtaking and equal distance continued




**13. Use the graph to determine (i) the time at which Courier B overtakes Courier A and (ii) their displacement then. [2 marks]**

**Answer / mark points:** The lines meet at t = 75 s and displacement = 225 m. This intersection is the overtaking event.

**Teacher prompt / common error:** Overtaking occurs at the crossing point of two displacement-time lines, not where their gradients are equal.

**14. Each courier reaches the marker at a displacement of 360 m. Determine the time each courier spends moving from the gate to the marker. [2 marks]**

**Answer / mark points:** Courier A moves for 120 s. Courier B reaches the marker at t = 102 s but starts at t = 30 s, so it moves for 102 - 30 = 72 s.

**Teacher prompt / common error:** Distinguish clock time from the time spent moving: subtract Courier B's start time.

**15. Calculate the gradient of each courier's displacement-time line. State what each gradient represents. [2 marks]**

**Answer / mark points:** Courier A: gradient = 360 / 120 = 3.0 m $s^{-1}$. Courier B: gradient = 360 / (102 - 30) = 5.0 m $s^{-1}$. Each gradient represents the courier's constant velocity.

**Teacher prompt / common error:** The steeper line represents the greater velocity. Include units for both gradients.

**16. Explain why Courier B overtakes Courier A even though Courier B starts later. [2 marks]**

**Answer / mark points:** Courier B has the greater displacement-time gradient, so it has the greater constant velocity. Its displacement increases more quickly, allowing it to catch and then pass Courier A.

**Teacher prompt / common error:** The explanation needs the link: greater gradient -> greater velocity -> catches up and passes.

### Closing review

At an intersection on a displacement-time graph, the objects have the same displacement at the same time.
A steeper straight line means a greater constant velocity; it does not mean that the velocity is 'accelerating'.