OCR A A Level Motion Graphs worksheet

35–40 minutes independent practice + 15–20 minutes 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.

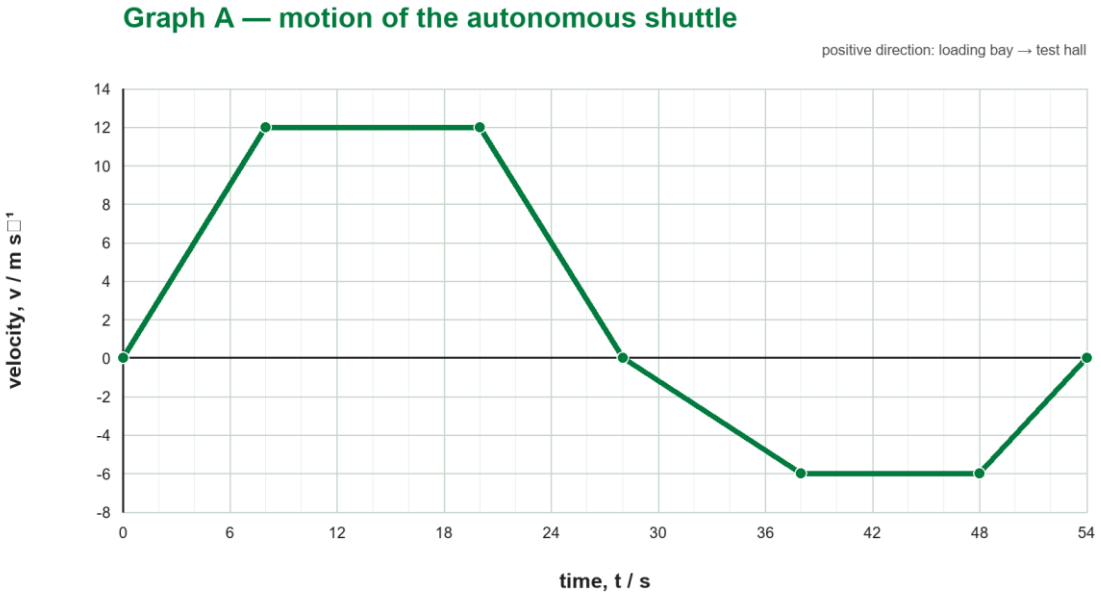
Scenario

An autonomous electric shuttle carries equipment between a loading bay and a test hall.
Use positive direction as loading bay → test hall. Graph B is a later, shorter calibration run measured from a marker.

Language routine for graph descriptions

Name the quantity first: displacement, velocity or speed.
Then say it increases, decreases or stays the same; where it changes, say whether the change is linear or non-linear.
Finally explain the motion using gradient or area. Avoid “the velocity is accelerating” — acceleration describes how velocity changes.

Graph A: velocity–time



Read values and gradients carefully from the scale. Areas below the time axis are negative displacement.

1. Graph A is a velocity–time graph. State what (i) its gradient and (ii) its signed area between the graph and the time axis represent. [2 marks]

2. At t = 33 s, state the shuttle's (i) velocity and (ii) speed. [2 marks]

3. State the maximum speed reached on Graph A and the time interval during which it is reached. [2 marks]

Graph A: calculation and description

4. Calculate the acceleration during the first 8.0 s of the run. [2 marks]

5. During 28 s to 38 s, calculate the acceleration. Then describe the shuttle's direction of travel and what happens to its speed. [3 marks]

Graph A: areas and precise language

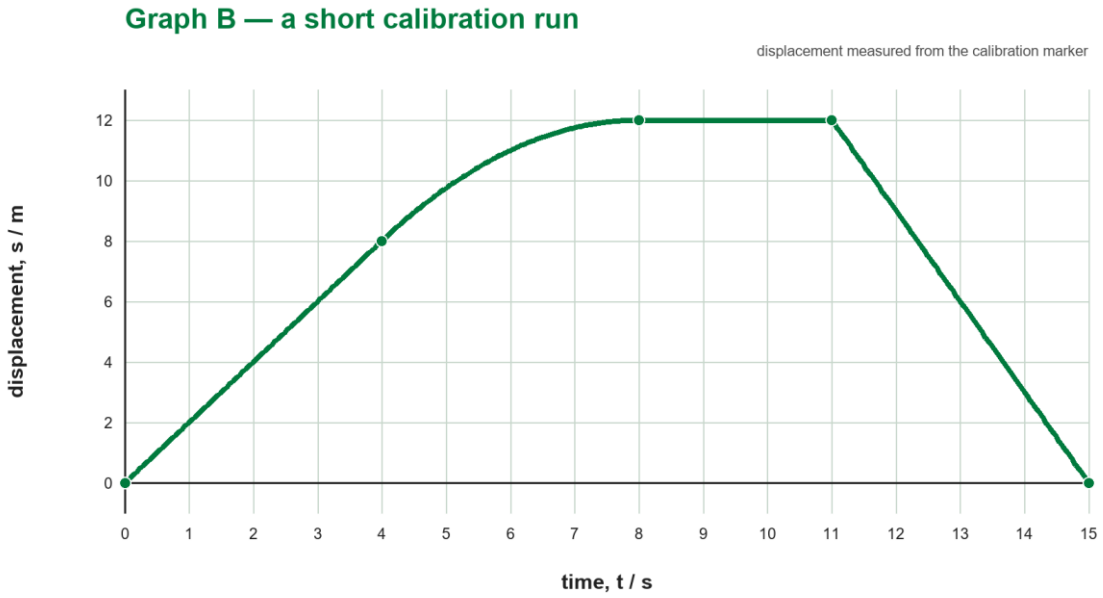
6. Describe the motion in each interval using the quantity–trend–linearity language: (a) 8–20 s, (b) 20–28 s and (c) 28–38 s. Do not say "the velocity is accelerating". [4 marks]

7. Use areas to calculate the shuttle's displacement from t = 0 s to t = 28 s. [3 marks]

8. Calculate (i) the resultant displacement and (ii) the total distance travelled during the whole 54 s journey. [4 marks]

9. Explain why the total distance travelled is not equal to the magnitude of the resultant displacement for this journey. [2 marks]

Graph B: displacement–time



For a displacement–time graph, the gradient gives velocity. A flat section has zero gradient.

10. State what the gradient of Graph B represents. [1 marks]

11. Describe the motion in each interval on Graph B using precise graph language: (a) 0–4 s, (b) 4–8 s, (c) 8–11 s and (d) 11–15 s. [4 marks]

Graph B: calculation and precise language

12. Use gradients of the straight sections of Graph B to calculate the velocity in 0–4 s and in 11–15 s. Hence state the maximum speed in the calibration run. [3 marks]

13. At t = 6 s, the data logger gives an instantaneous velocity of +1.0 m s^{-1}. Explain why this is consistent with the 4–8 s part of Graph B and why this velocity is lower than during the first 4 s. [2 marks]

14. Using Graph B, calculate (i) the total distance travelled and (ii) the resultant displacement from 0 s to 15 s. [2 marks]

15. A pupil writes: “The displacement accelerates from 4 s to 8 s, then the velocity is stationary from 8 s to 11 s.” Rewrite both parts so that the quantities and their changes are described correctly. [3 marks]

Review and improve

- □ I can distinguish displacement, velocity and speed.
- □ I can use a gradient or an area with the correct physical meaning.
- □ I can describe a graph without saying that a quantity ‘accelerates’.