

Motion graphs

AQA GCSE Physics 8463 and Combined Science Trilogy 8464 | Paper 2 | Tier pathways below

Suggested 35-40 minutes independent work + 15-20 minutes review | 47 marks per pathway

Specification points covered

8463 4.5.6.1.1-1.3 / 8464 6.5.4.1.1-1.3: distance, displacement, speed and velocity

8463 4.5.6.1.4 / 8464 6.5.4.1.4: distance-time graphs; tangents are Higher only

8463 4.5.6.1.5 / 8464 6.5.4.1.5: acceleration and velocity-time graphs; areas are Higher only

A delivery robot carries parcels between collection points along a straight lane. Its team checks recorded journeys and a speed limit near pedestrians. The graph tests are separate; do not combine their data.

Everyone: Questions 1-3. Foundation: then Question 4; omit Question 5. Higher: then Question 5; omit Question 4. Show working and units. Speed = distance / time; acceleration = change in velocity / time.

1 Checking the journey

1(a) State how velocity differs from speed. [1 mark]

1(b) In one journey the robot moves 15 m east, then 20 m west, then 5 m east. Calculate its total distance travelled and its final displacement. [2 marks]

1(c) Two separate deliveries each cover 12 m at constant speed. Calculate the time at 1.5 m s^{-1} , then the time at 2.0 m s^{-1} . [2 marks]

1(d) Near pedestrians the speed limit is 1.5 m s^{-1} . In a test the robot covers 12 m in 5.0 s. Calculate its average speed and decide whether it could have stayed within the limit throughout. [2 marks]

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2 Distance travelled during a delivery

Figure 1 records total distance travelled, not position. The robot moves east from 0-10 s, west from 20-30 s, then east from 30-40 s.

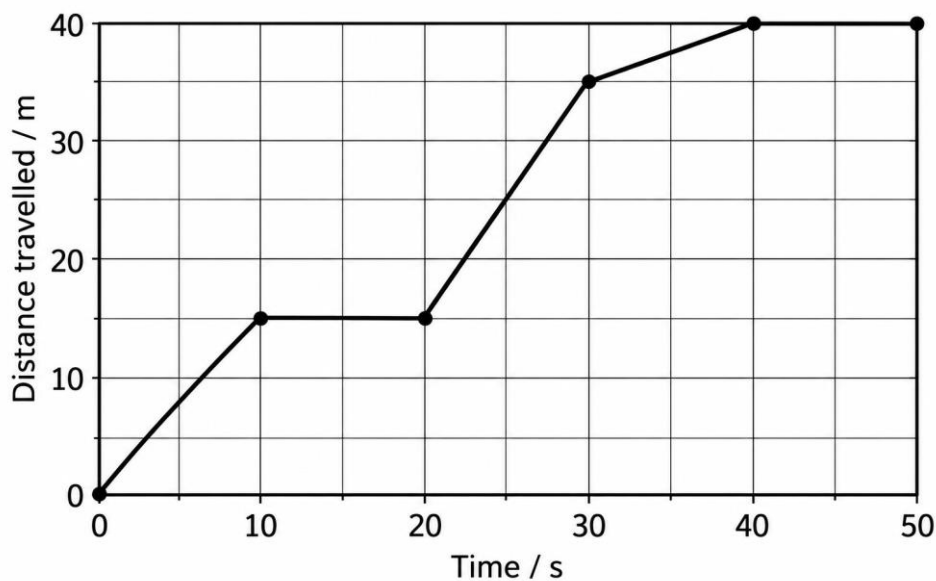


Figure 1

2(a) Use Figure 1 to read the distance travelled by 5.0 s. [1 mark]

2(b) Read the distance travelled by 25 s. [1 mark]

2(c) State both time intervals when the robot is stationary. [1 mark]

2(d) Calculate the speed from 0-10 s using the gradient. [1 mark]

2(e) Calculate the speed from 20-30 s. [1 mark]

2(f) Calculate the speed from 30-40 s. [1 mark]

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2 Distance travelled during a delivery continued

2(g) Calculate the average speed over the full 50 s. Explain why the stopped time must be included. [2 marks]

2(h) State the interval with the greatest speed and explain which graph feature shows this. [2 marks]

2(i) A pupil expects the line to fall from 20-30 s because the robot moves west. Explain why the total-distance graph still rises. [2 marks]

3 A new straight run

Figure 2 is a different test, with east positive. The robot moves only east or is stationary. The final section is missing: from 20-24 s its velocity stays at 1.0 m s^{-1} .

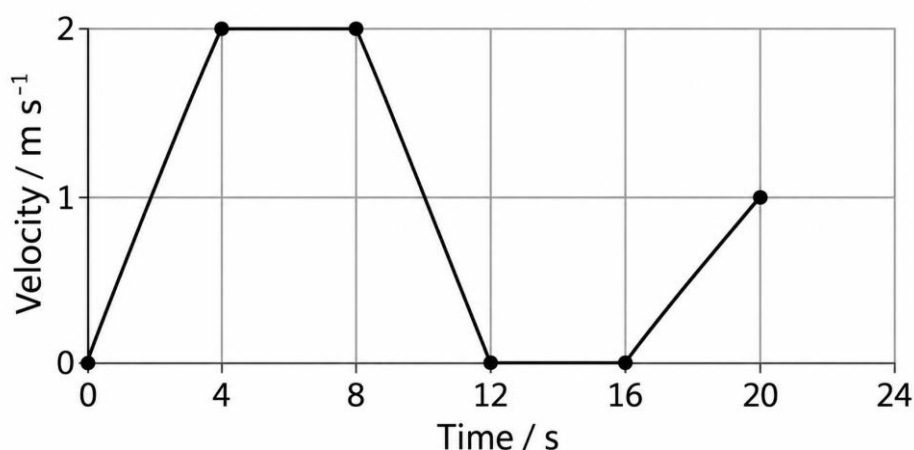


Figure 2

3(a) Complete Figure 2 for 20-24 s by drawing directly on the graph. [1 mark]

3(b) State the velocity at 6.0 s, including direction. [1 mark]

3(c) Calculate the acceleration from 0-4.0 s. [1 mark]



3 A new straight run continued

3(d) Calculate the signed acceleration from 8-12 s. East is positive. [1 mark]

3(e) Describe the velocity and acceleration from 4-8 s. [2 marks]

3(f) State the time interval when the robot is stationary. [1 mark]

3(g) Describe how velocity changes from 16-20 s and state whether acceleration is constant. [2 marks]

3(h) A trainee writes: the velocity is accelerating at 0.50 m s^{-2} from 0-4 s. Rewrite this using the correct quantities and language. [2 marks]

3(i) A pupil says the falling line from 8-12 s means the robot is moving west. Explain the error. [2 marks]

3(j) Describe how a fixed camera, a metre scale and video timestamps could provide distance-time data for a straight eastward run. Explain how the data would show whether the speed is constant. [4 marks]



4 Foundation practice and application

Foundation pathway: complete this question instead of Question 5. Table 1 is a new eastward test. Assume constant speed between each pair of adjacent readings.

Table 1

Time / s	0	2	4	6	8
Distance travelled / m	0	2	6	10	12

4(a) Use Table 1 to calculate the average speed from 0-4 s. **[1 mark]**

4(b) Calculate the average speed from 4-8 s. **[1 mark]**

4(c) Calculate the speed from 2-4 s and from 6-8 s. **[2 marks]**

4(d) The lane speed limit is 1.8 m s^{-1} . Identify every interval in Table 1 that exceeds it and justify your answer. **[2 marks]**

4(e) After 8 s the robot has 6.0 m left to travel. Calculate the extra time at a constant 1.5 m s^{-1} . **[1 mark]**

4(f) A pupil says the equal average speeds in (a) and (b) prove that the speed was constant throughout 0-8 s. Explain why this conclusion is wrong. **[2 marks]**

4(g) For another constant-speed run, each video position has the same measurement uncertainty. Timing is precise. Explain why using positions 2.0 s apart instead of 0.20 s apart can reduce the effect on the calculated speed. **[2 marks]**

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5 Higher only areas and tangents

Higher pathway: complete this question instead of Question 4. Use the completed Figure 2 for parts (a)-(c). All velocities are non-negative, so graph area gives distance.

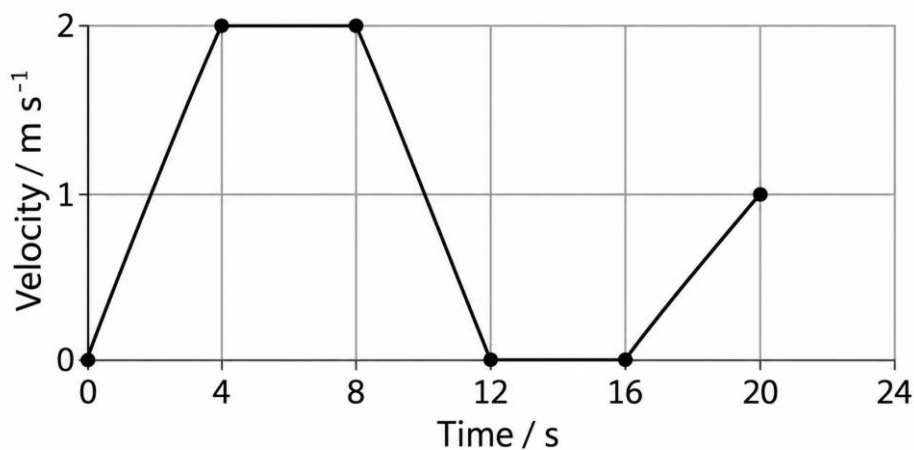


Figure 2

5(a) Higher only: calculate the distance travelled from 0-12 s using Figure 2. **[2 marks]**

5(b) Higher only: calculate the total distance travelled from 0-24 s, including your completed graph section. **[2 marks]**

5(c) Higher only: calculate the average speed over the 24 s run. **[1 mark]**



5 Higher only areas and tangents continued

Figure 3 shows a separate eastward test with a smooth increase in speed. Draw the tangent for part (d) directly on this graph.

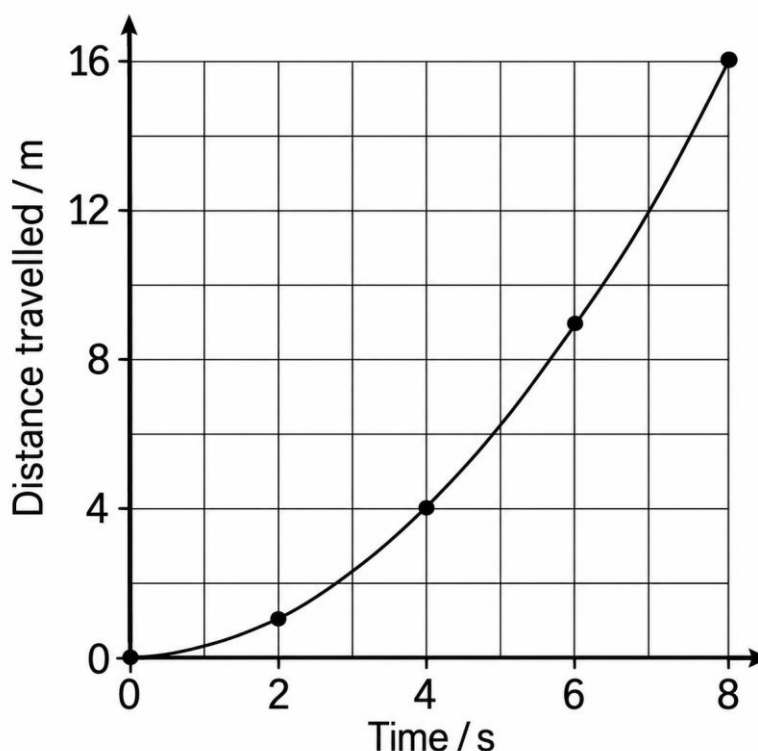


Figure 3

5(d) Higher only: draw a tangent to Figure 3 at 4.0 s. Use two widely separated points on your tangent to determine the instantaneous speed. **[2 marks]**

5(e) Higher only: describe how distance and speed change during the run in Figure 3. Refer to the curve and its gradient. **[2 marks]**

5(f) Higher only: calculate the average speed from 0-8 s in Figure 3. A pupil says its agreement with the speed at 4 s proves constant speed. Use the graph to evaluate this claim. **[2 marks]**

Review: correct one graph-reading error and rewrite one description using the quantity that changes.

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