IG.P2 Distance-Time and Velocity-Time Graphs

Total Marks

EDEXCEL 4PH1 · Calculator allowed · about 65 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Read off from the distance-time graph of a pedestrian walking along a straight path: at 0 minutes the distance is 0 m; at 5 minutes the distance is 300 m. State the average speed of the pedestrian between 0 and 5 minutes in m/s.

(Total for Question 1 is 3 marks)

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2 A car travels with constant speed. On a distance-time graph its line is straight and passes through (2 s, 10 m) and (6 s, 34 m). Calculate the speed of the car in m/s.

(Total for Question 2 is 2 marks)

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3 Describe the motion shown by a distance-time graph that is a horizontal straight line at 20 m from the origin for all times between 0 s and 10 s.

(Total for Question 3 is 2 marks)

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4 A cyclist starts from rest and accelerates uniformly so the distance-time graph is a curve. Explain how the shape of the curve shows the cyclist is accelerating.

(Total for Question 4 is 3 marks)

5 Read off from a velocity-time graph a vehicle that travels at 12 m/s from t = 0 s to t = 4 s, then decelerates linearly to 0 m/s at t = 8 s. Determine the acceleration during the deceleration phase, in m/s^2.

(Total for Question 5 is 3 marks)

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6 A velocity-time graph shows a car moving at 10 m/s for 6 s, then accelerating uniformly to 22 m/s over the next 4 s. Calculate the distance travelled during the acceleration interval (from t = 6 s to t = 10 s) using the area under the velocity-time graph. Give your answer in metres.

(Total for Question 6 is 4 marks)

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7 Sketch on a blank axes a velocity-time graph for a toy car that starts from rest, accelerates uniformly to 5 m/s in 2 s, then continues at 5 m/s for 3 s, and finally brakes uniformly to rest in 1 s. Label the time points t = 0 s, 2 s, 5 s and 6 s and the velocities 0 and 5 m/s. No precise drawing required, but shapes and labels must be correct.

(Total for Question 7 is 3 marks)

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8 Using the graph sketched in Question 7, calculate the total distance travelled by the toy car from t = 0 to t = 6 s by finding the area under the velocity-time graph. Give your answer in metres.

(Total for Question 8 is 3 marks)

9 A runner completes a two-stage journey shown on a velocity-time graph: first stage, constant speed 4 m/s for 10 s; second stage, accelerates uniformly to 12 m/s over 5 s. Calculate the total distance run during the whole 15 s interval by using areas under the velocity-time graph. Show steps and give units.

(Total for Question 9 is 4 marks)

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10 A distance-time graph shows an object moving away from the origin with constant speed, covering 90 m in 30 s. Read off the speed from the graph in m/s.

(Total for Question 10 is 2 marks)

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11 A lorry is shown on a velocity-time graph as follows: accelerates uniformly from 0 to 8 m/s in 4 s, continues at 8 m/s for 6 s, then decelerates uniformly to 2 m/s in 2 s. Calculate (a) the acceleration during the initial 4 s, and (b) the distance covered during the whole 12 s journey by using the areas under the graph. Give units.

(a) Calculate the acceleration during the initial 4 s (from 0 to 8 m/s). **(2)**

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(b) Calculate the distance covered during the whole 12 s journey using areas under the velocity-time graph. **(2)**

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(Total for Question 11 is 4 marks)

12 Describe the motion of a vehicle shown on a distance-time graph that is a straight line with increasing gradient for the first 5 s, then a straight horizontal line for the next 5 s, and finally a straight line returning to the origin over 5 s. Use words describing speed and direction.

(Total for Question 12 is 2 marks)

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13 A velocity-time graph shows a toy train moving at 3 m/s for 4 s, then accelerating uniformly to 9 m/s over 3 s, then maintaining 9 m/s for 5 s. Calculate (a) the acceleration during the 3 s interval, and (b) the distance covered in the entire 12 s. Show working and include units.

(a) Calculate the acceleration during the 3 s interval (from 3 m/s to 9 m/s). **(1)**

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(b) Calculate the distance covered in the whole 12 s. **(2)**

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(Total for Question 13 is 3 marks)

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14 On a velocity-time graph a cyclist travels at -2 m/s (negative sign indicates towards the origin) for 5 s, then reverses direction and accelerates to +6 m/s over 4 s. Calculate the change in velocity and the average acceleration during the 4 s interval. Give units.

(Total for Question 14 is 3 marks)

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15 A vehicle is driven so that its velocity-time graph between t = 0 and t = 9 s is as follows: from 0 to 3 s constant at 0 m/s (stationary), from 3 to 6 s accelerates uniformly to 15 m/s, from 6 to 9 s decelerates uniformly to 6 m/s. Calculate the total displacement from t = 3 s to t = 9 s using areas under the velocity-time graph. Give your answer in metres.

(Total for Question 15 is 3 marks)

Mark scheme · IG.P2 Distance-Time and Velocity-Time Graphs

Question 1

- **M1** forms change in distance over change in time fraction, (300 - 0) / (5 min)
- **M1** converts 5 minutes to seconds or converts result to m/s, e.g. 5 min = 300 s
- **A1** gives final answer 1.0 m/s cao
- **Answer: 1.0 m/s**

Question 2

- **M1** uses gradient = change in distance / change in time = (34 - 10)/(6 - 2)
- **A1** gives 6 m/s cao
- **Answer: 6 m/s**

Question 3

- **B1** states that distance does not change with time
- **B1** concludes the object is stationary at 20 m from the origin
- **Answer: The object is stationary; it stays at 20 m from the origin for the whole 0 s to 10 s interval.**

Question 4

- **B1** notes the curve gets steeper with time
- **B1** links steeper gradient to increasing speed
- **B1** concludes speed is increasing so the cyclist is accelerating
- **Answer: The curve becomes steeper over time, so the gradient, which equals speed, increases. Therefore the cyclist's speed increases and the cyclist is accelerating.**

Question 5

- **M1** uses gradient = change in velocity / change in time = (0 - 12)/(8 - 4)
- **A1** gives acceleration = -3.0 m/s^2 cao
- **B1** states negative sign means deceleration or slowing down
- **Answer: -3.0 m/s^2 (deceleration of 3.0 m/s^2)**

Question 6

- **M1** recognises area under v-t graph for the interval is a trapezium and uses area = (sum of parallel sides)/2 x height
- **M1** substitutes velocities and time: area = (10 + 22)/2 x 4
- **A1** evaluates area = 64 m cao
- **B1** states unit m with final answer
- **Answer: 64 m**

Question 7

- **B1** shows a straight line from (0,0) to (2,5) representing uniform acceleration
- **B1** shows a horizontal line from (2,5) to (5,5) representing constant speed
- **B1** shows a straight line from (5,5) to (6,0) representing uniform braking to rest, and labels times and velocities
- **Answer: Sketch showing: straight line 0 to (2,5), horizontal to (5,5), straight down to (6,0); axes labelled and points marked.**

Question 8

- **M1** splits area into triangle for 0-2 s, rectangle for 2-5 s, triangle for 5-6 s, or equivalent
- **M1** calculates areas: triangle 0-2 s = 0.5 x 2 x 5 = 5 m, rectangle 2-5 s = 3 x 5 = 15 m, triangle 5-6 s = 0.5 x 1 x 5 = 2.5 m
- **A1** gives total = 22.5 m cao with unit
- **Answer: 22.5 m**

Question 9

- **M1** calculates distance in stage 1 as area of rectangle = 4 x 10
- **M1** recognises stage 2 area is trapezium or triangle+rectangle and uses area = (4 + 12)/2 x 5
- **A1** evaluates stage 1 = 40 m and stage 2 = 40 m cao
- **B1** gives total = 80 m with unit
- **Answer: 80 m**

Question 10

- **M1** uses speed = distance / time = 90 / 30
- **A1** gives speed = 3.0 m/s cao
- **Answer: 3.0 m/s**

Question 11

- (a) **M1** uses gradient = change in velocity / change in time = (8 - 0)/4
- (a) **A1** gives acceleration = 2.0 m/s^2 cao
- **(a) Answer: 2.0 m/s^2**
- (b) **M1** splits into triangle 0-4 s, rectangle 4-10 s, trapezium 10-12 s or equivalent and calculates areas
- (b) **A1** evaluates total distance = 16 + 48 + 10 = 74 m cao
- **(b) Answer: 74 m**

Question 12

- **B1** states first period is speeding up (increasing speed) away from origin
- **B1** states second period is moving at constant speed, then final period is returning to origin meaning moving back towards start and covering decreasing distance
- **Answer: From 0-5 s the vehicle is accelerating and increasing its speed away from the origin. From 5-10 s it moves at constant speed. From 10-15 s it moves back towards the origin, its distance from the origin decreasing until it reaches the origin.**

Question 13

- (a) **A1** gives acceleration = (9 - 3)/3 = 2.0 m/s^2 cao
- **(a) Answer: 2.0 m/s^2**
- (b) **M1** calculates areas for sections: rectangle 0-4 s = 3 x 4, trapezium 4-7 s = (3 + 9)/2 x 3, rectangle 7-12 s = 9 x 5
- (b) **A1** adds values: 12 + 18 + 45 = 75 m cao
- **(b) Answer: 75 m**

Question 14

- **M1** calculates change in velocity = final - initial = 6 - (-2) = 8 m/s
- **M1** uses acceleration = change in velocity / time = 8 / 4
- **A1** gives acceleration = 2.0 m/s^2 cao and labels change in velocity 8 m/s
- **Answer: Change in velocity = 8 m/s; average acceleration = 2.0 m/s^2**

Question 15

- **M1** splits into trapezium 3-6 s with velocities 0 to 15 and time 3, and trapezium 6-9 s with velocities 15 to 6 and time 3, or uses triangle+rectangle forms
- **M1** calculates areas: 3-6 s area = (0 + 15)/2 x 3 = 22.5 m; 6-9 s area = (15 + 6)/2 x 3 = 31.5 m
- **A1** gives total displacement = 54.0 m cao
- **Answer: 54.0 m**