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PHYSICS KEY BOOK

Class 9 | Unit 2

KINEMATICS

GRAPH PRACTICE

What is inside

#	Contents
1	Graph-based MCQs
2	Short Response Graph Questions
3	Numerical Questions Using Graphs
4	Draw the Graph Questions
5	Theory Questions on Graphs
6	Answers and Solutions

About this part

Graph practice for Class 9 Physics Unit 2 (Kinematics) in the FBISE paper pattern: MCQs, short response, numerical, draw-the-graph and theory questions on distance-time and speed-time graphs. Figures are numbered 1 to 14 in the order they first appear, and each solution shows its steps, because every step carries marks.

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BEFORE YOU START

This set has graph-based questions in the FBISE paper pattern: MCQs, short response, numerical (long) response, draw-the-graph questions and theory questions. The figures are numbered 1 to 14 in the order they first appear, and the questions follow the same order. Answers and solutions are at the end.

Tips for graph questions

- Gradient (slope) of a **distance-time** graph = **speed** ($\Delta s \div \Delta t$).
- Gradient (slope) of a **speed-time** graph = **acceleration** ($\Delta v \div \Delta t$).
- **Area** under a speed-time graph = **distance** (rectangle = $v \times t$, triangle = $\frac{1}{2} \times v \times t$, trapezium = $\frac{1}{2}$ × (sum of parallel sides) × width).
- Horizontal line on a distance-time graph = **rest**. Horizontal line on a speed-time graph = **uniform speed, zero acceleration**.
- Always change units first (km/h ÷ 3.6 = m/s) and write the unit with every answer.

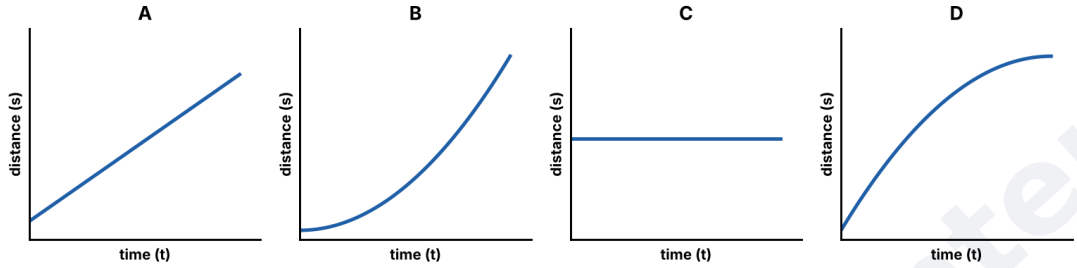
Exam tip: For every graph numerical, write the formula first, then put in the values from the graph, then write the answer with its unit. For area questions, split the graph into rectangles and triangles and add them. Every step carries marks.

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PART A GRAPH-BASED MCQS (1 MARK EACH)

Choose the correct option. The figures are given before the questions that use them.

Figure 1: Four distance-time graphs



1. Which graph in Figure 1 shows a body **at rest**?

A. Graph A **B.** Graph B **C.** Graph C **D.** Graph D

2. Which graph in Figure 1 shows a body moving with **uniform (constant) speed**?

A. Graph A **B.** Graph B **C.** Graph C **D.** Graph D

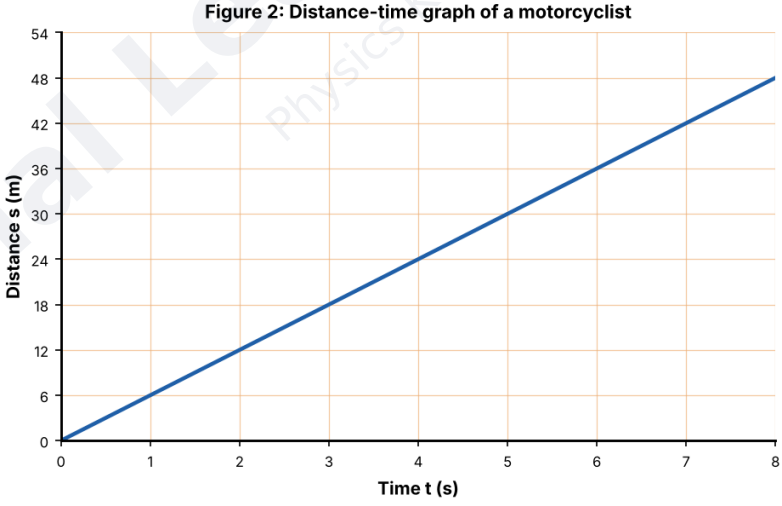
3. Which graph in Figure 1 shows a body with **increasing speed**?

A. Graph A **B.** Graph B **C.** Graph C **D.** Graph D

4. Which graph in Figure 1 shows a body with **decreasing speed**?

A. Graph A **B.** Graph B **C.** Graph C **D.** Graph D

Figure 2: Distance-time graph of a motorcyclist

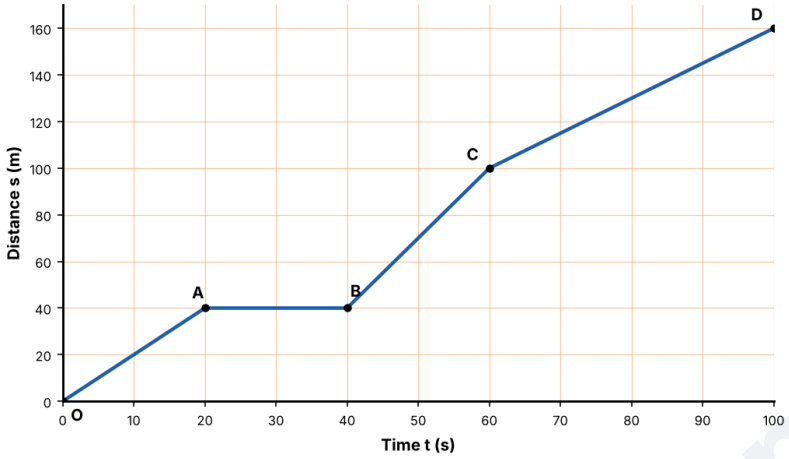


5. The speed of the motorcyclist in Figure 2 is:

A. 3 m/s **B.** 6 m/s **C.** 12 m/s **D.** 48 m/s

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Figure 3: Distance-time graph of a boy walking



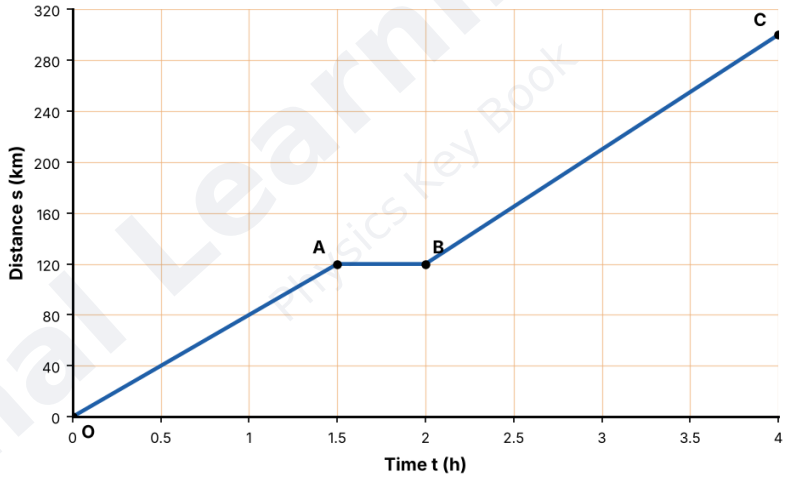
6. In Figure 3, the boy is at rest during:

A. OA **B.** AB **C.** BC **D.** CD

7. In Figure 3, the speed of the boy in part BC is:

A. 1.5 m/s **B.** 2 m/s **C.** 3 m/s **D.** 5 m/s

Figure 4: Distance-time graph of a bus on the motorway

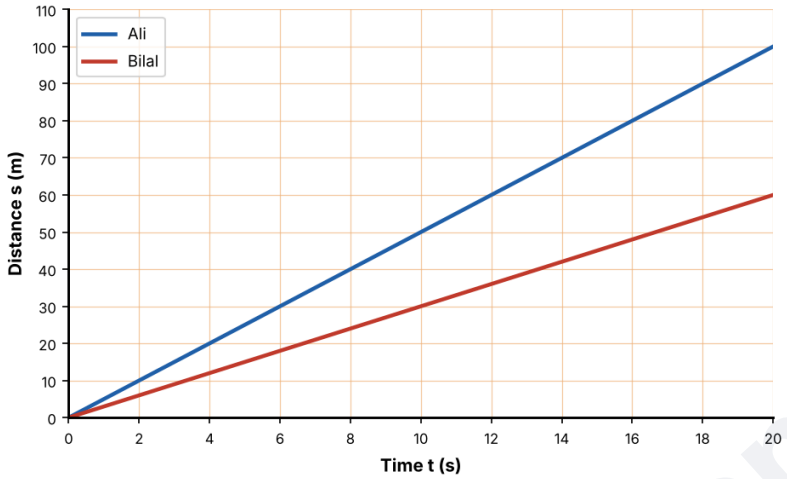


8. The average speed of the bus for the whole journey in Figure 4 is:

A. 60 km/h **B.** 75 km/h **C.** 80 km/h **D.** 90 km/h

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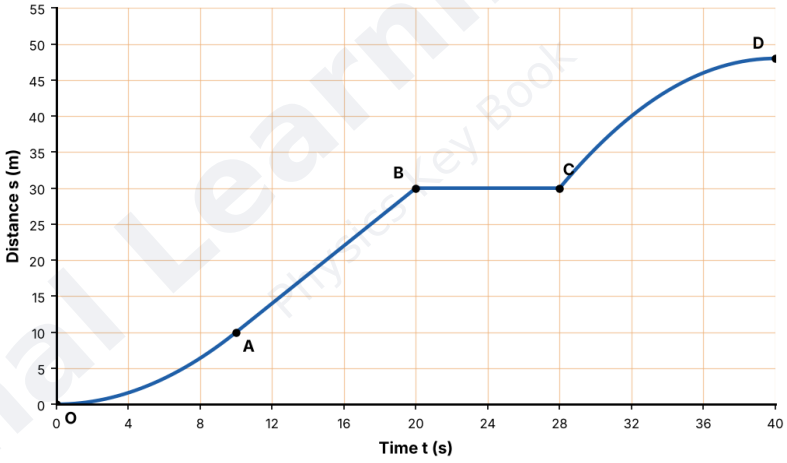
Figure 5: Distance-time graphs of Ali and Bilal



9. In Figure 5, which boy has the greater speed?

A. Ali
B. Bilal
C. Both have the same speed
D. It cannot be told

Figure 6: Distance-time graph of a toy car

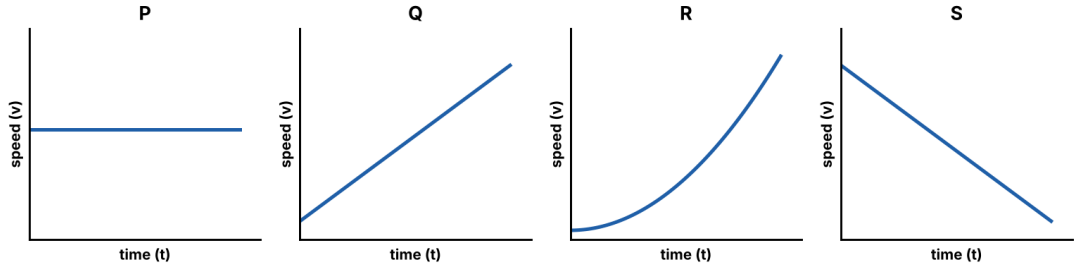


10. In Figure 6, the toy car is at rest during:

A. OA **B.** AB **C.** BC **D.** CD

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Figure 7: Four speed-time graphs



11. Which speed-time graph in Figure 7 shows **zero acceleration**?

A. Graph P **B.** Graph Q **C.** Graph R **D.** Graph S

12. Which speed-time graph in Figure 7 shows **uniform acceleration**?

A. Graph P **B.** Graph Q **C.** Graph R **D.** Graph S

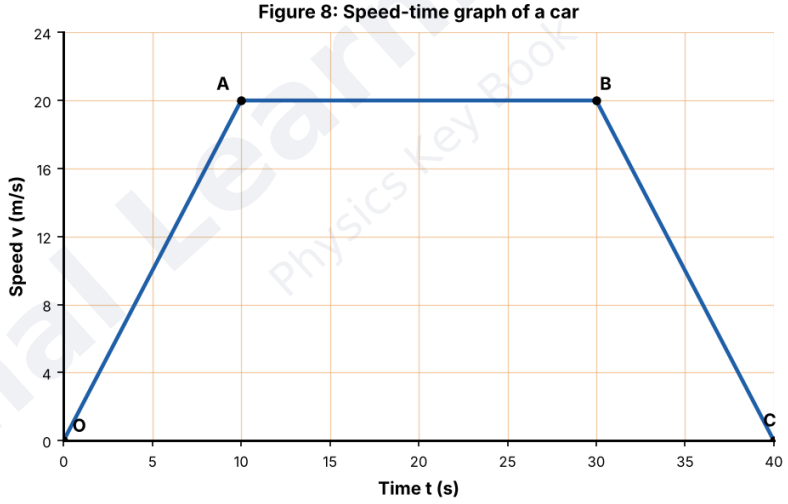
13. Which speed-time graph in Figure 7 shows **uniform deceleration**?

A. Graph P **B.** Graph Q **C.** Graph R **D.** Graph S

14. Which speed-time graph in Figure 7 shows **non-uniform acceleration**?

A. Graph P **B.** Graph Q **C.** Graph R **D.** Graph S

Figure 8: Speed-time graph of a car



15. In Figure 8, the acceleration of the car in the first 10 s is:

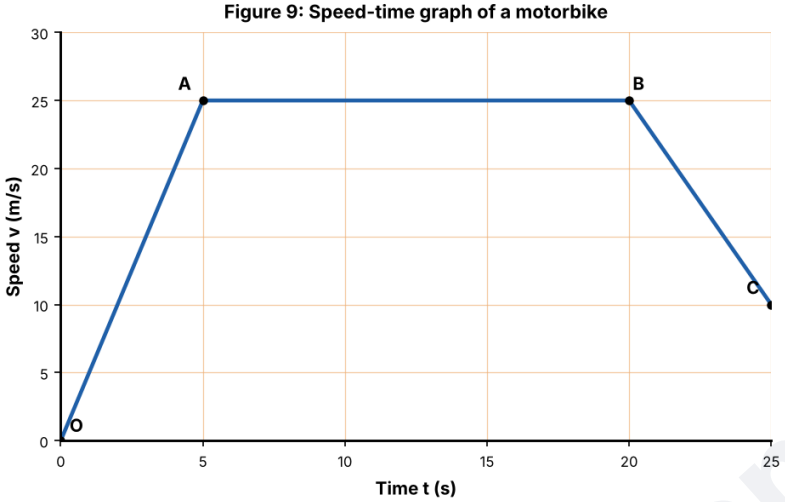
A. 0.5 m/s² **B.** 1 m/s² **C.** 2 m/s² **D.** 20 m/s²

16. In Figure 8, the distance covered by the car from 10 s to 30 s is:

A. 200 m **B.** 400 m **C.** 600 m **D.** 20 m

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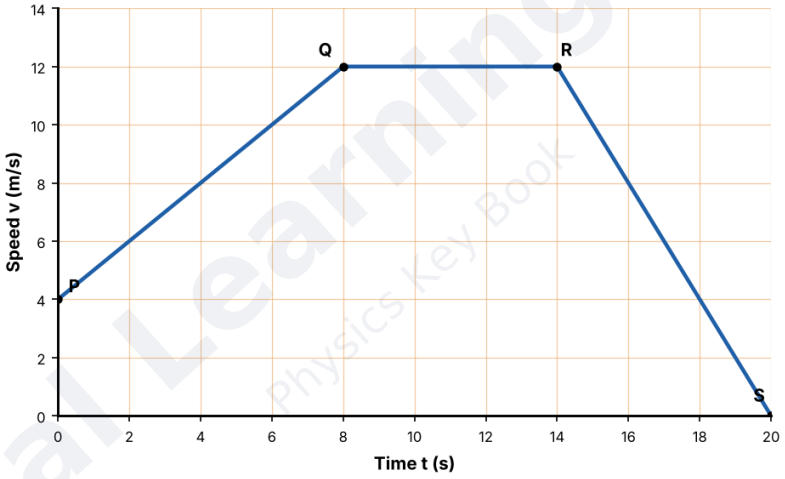
Figure 9: Speed-time graph of a motorbike



17. The distance covered by the motorbike during part AB of Figure 9 is:

A. 25 m **B.** 125 m **C.** 375 m **D.** 525 m

Figure 10: Speed-time graph of a cyclist

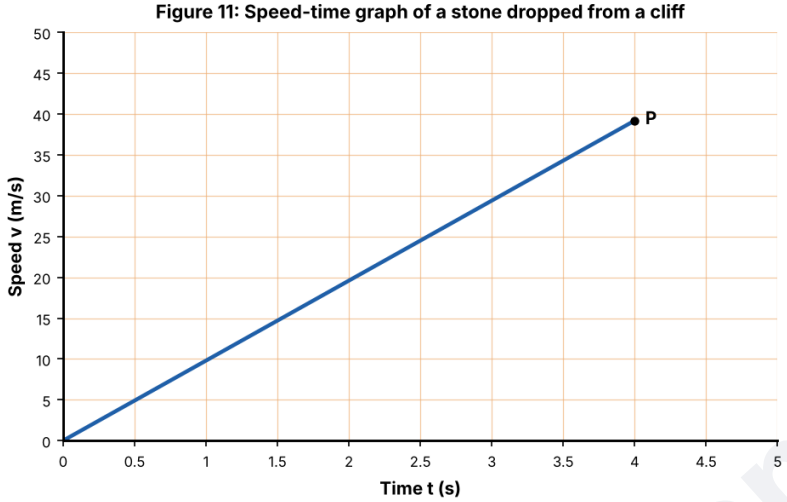


18. The speed of the cyclist at t = 0 s in Figure 10 is:

A. 0 m/s **B.** 4 m/s **C.** 8 m/s **D.** 12 m/s

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Figure 11: Speed-time graph of a stone dropped from a cliff



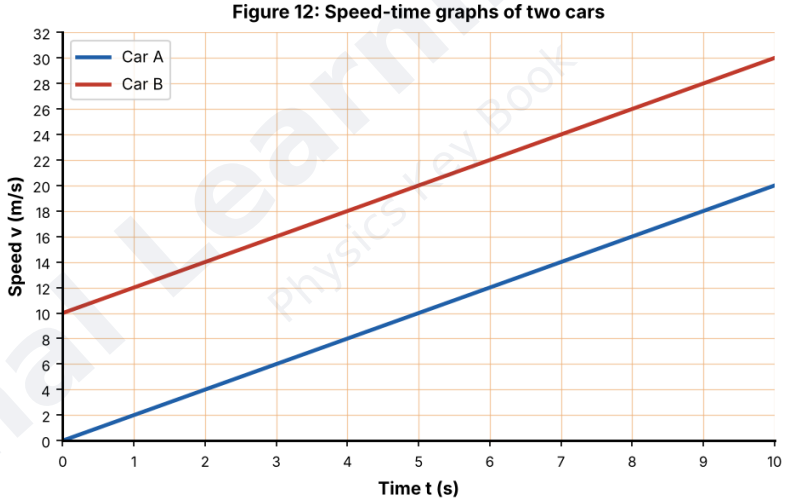
19. The slope of the graph in Figure 11 is equal to:

A. 4 m/s² **B.** 9.8 m/s **C.** 9.8 m/s² **D.** 39.2 m/s²

20. The distance fallen by the stone in 4 s (Figure 11) is:

A. 39.2 m **B.** 78.4 m **C.** 156.8 m **D.** 19.6 m

Figure 12: Speed-time graphs of two cars

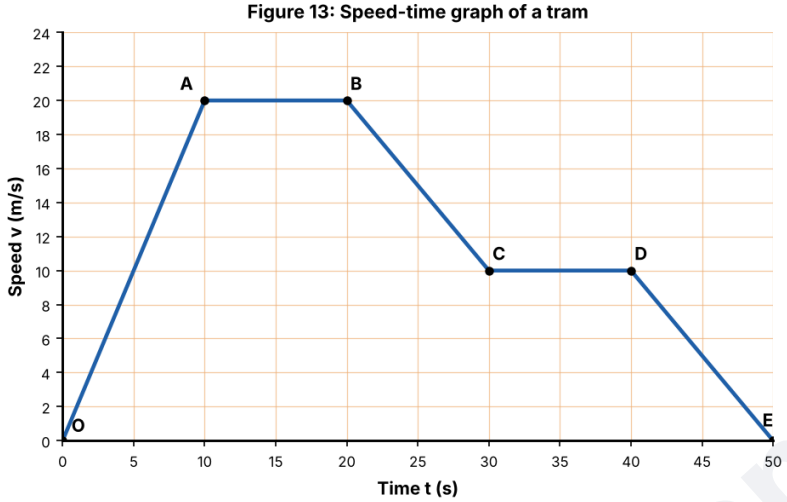


21. The lines for Car A and Car B in Figure 12 are parallel. This means:

A. Both cars have the same speed at every instant
B. Both cars have the same acceleration
C. Both cars cover the same distance
D. Both cars are at rest

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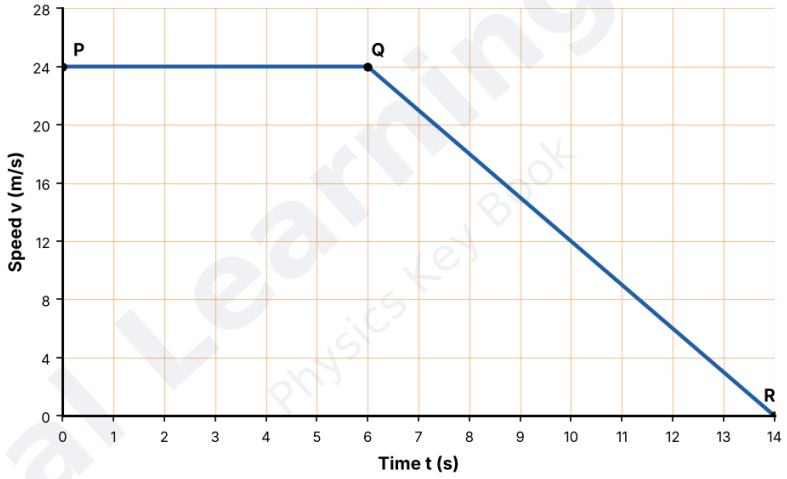
Figure 13: Speed-time graph of a tram



22. In Figure 13, the tram has zero acceleration during:

A. OA and BC **B.** AB and CD **C.** BC and DE **D.** OA and DE

Figure 14: Speed-time graph of a car that brakes



23. The acceleration of the car in Figure 14 from t = 6 s to t = 14 s is:

A. +3 m/s² **B.** 0 m/s² **C.** −3 m/s² **D.** −24 m/s²

24. The slope of a distance-time graph can **never** be negative because:

A. speed is a vector
B. distance never decreases
C. time can be negative
D. acceleration is always positive

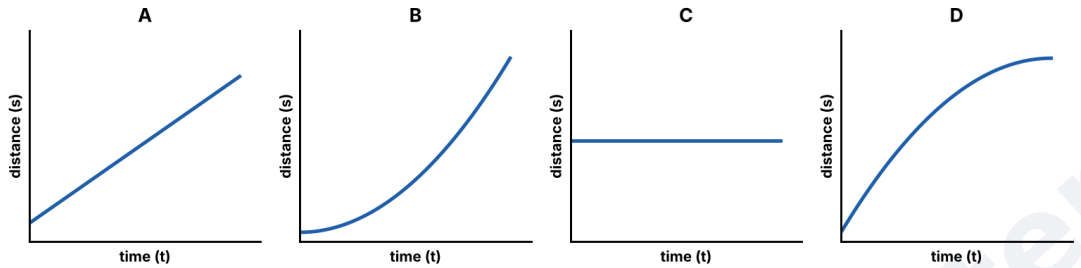
25. The area under a speed-time graph represents:

A. acceleration **B.** displacement only **C.** distance travelled **D.** change in speed

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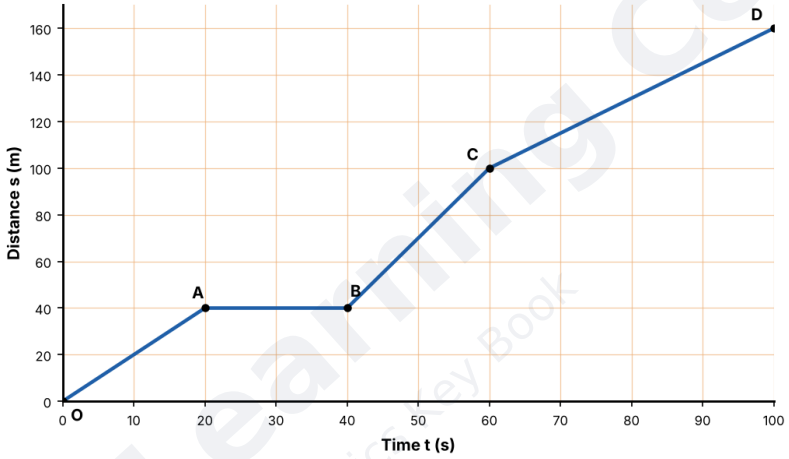
PART B SHORT RESPONSE GRAPH QUESTIONS (2 MARKS EACH)

Figure 1: Four distance-time graphs



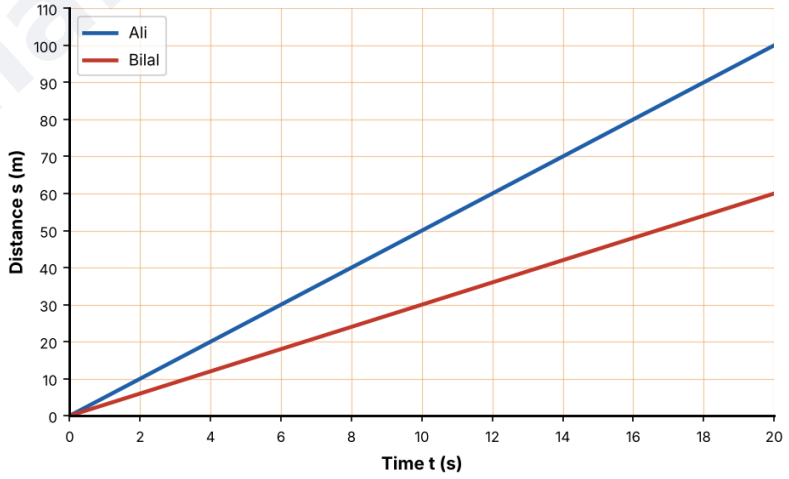
B1. Name the type of motion shown by each graph (A, B, C, D) in Figure 1, and give a reason for each from the slope.

Figure 3: Distance-time graph of a boy walking



B2. In Figure 3, why is the part AB of the graph horizontal? What does it show?

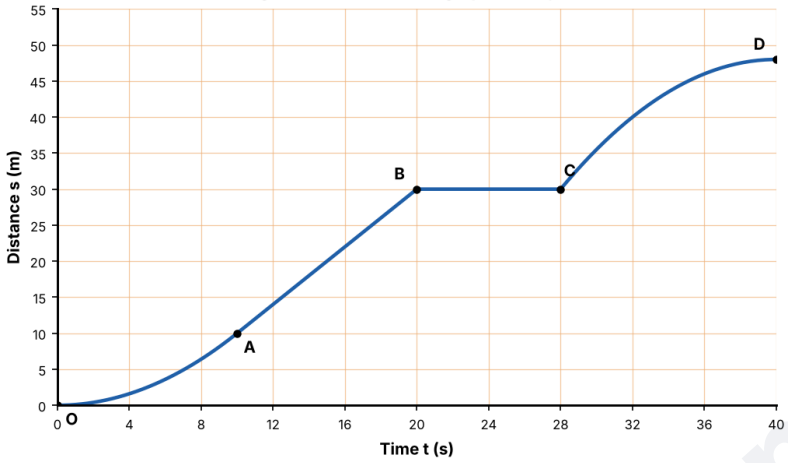
Figure 5: Distance-time graphs of Ali and Bilal



B3. Figure 5 shows the distance-time graphs of Ali and Bilal. Who is moving faster? Explain using the gradient.

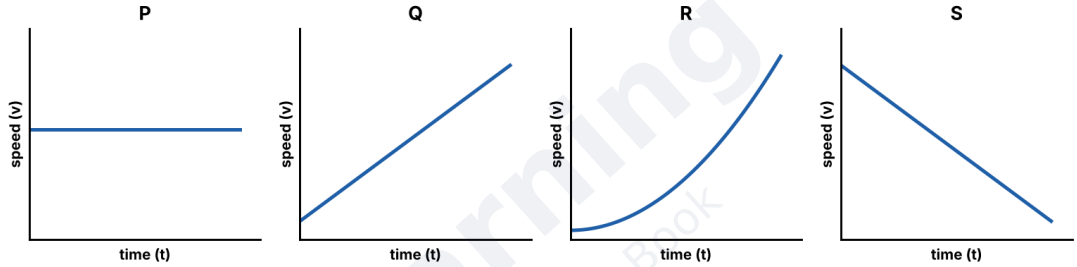
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Figure 6: Distance-time graph of a toy car



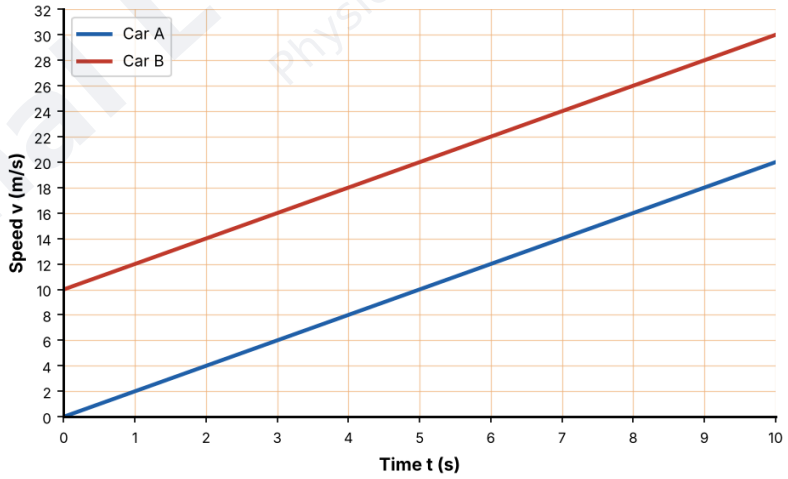
B4. Figure 6 shows the distance-time graph of a toy car. Describe the motion of the car in parts OA, AB, BC and CD.

Figure 7: Four speed-time graphs



B5. What does the slope tell about acceleration for each graph (P, Q, R, S) in Figure 7?

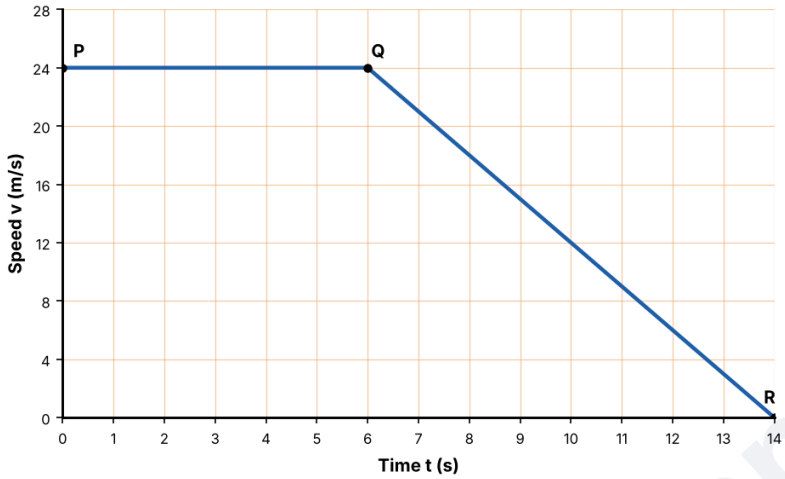
Figure 12: Speed-time graphs of two cars



B6. In Figure 12, the graphs of Car A and Car B are parallel. What do you conclude about their accelerations? Which car covers more distance in 10 s? Give a reason.

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Figure 14: Speed-time graph of a car that brakes



B7. What does the negative slope of the line in Figure 14 (from 6 s to 14 s) show about the motion of the car?

B8. A student draws a distance-time graph that slopes downward. Explain why this is not possible.

B9. A speed-time graph is a horizontal straight line above the time axis. What does it tell about the acceleration and the motion of the body?

B10. A speed-time graph is a straight line lying on the time axis. What does it show about the body?

B11. Differentiate between the slope of a distance-time graph and the slope of a speed-time graph.

B12. How can you find the distance travelled by a body from its speed-time graph if the graph is a rectangle? Write the formula.

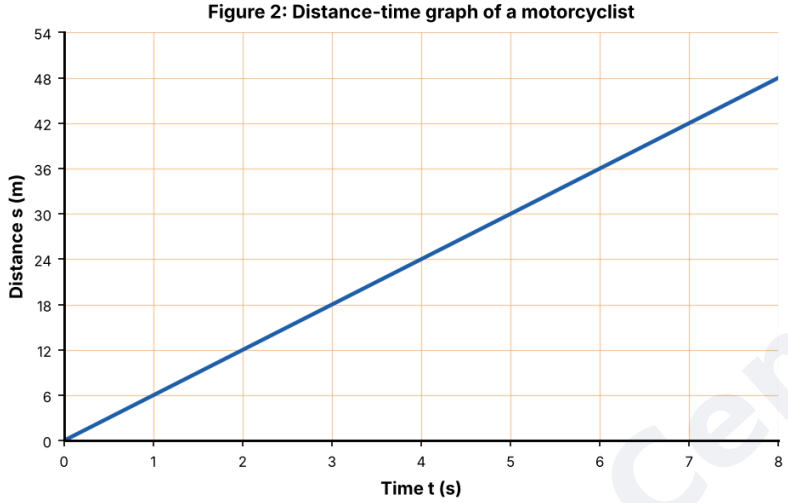
B13. Which of the two graphs, distance-time or speed-time, is a straight line parallel to the time axis for a body moving with uniform speed? Draw both sketches.

B14. A distance-time graph is a curve bending upward. What does this tell you about the speed of the body?

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PART C NUMERICAL QUESTIONS USING GRAPHS (LONG RESPONSE)

Figure 2: Distance-time graph of a motorcyclist



C1. (Figure 2, 4 marks)

Use Figure 2 (motorcyclist).

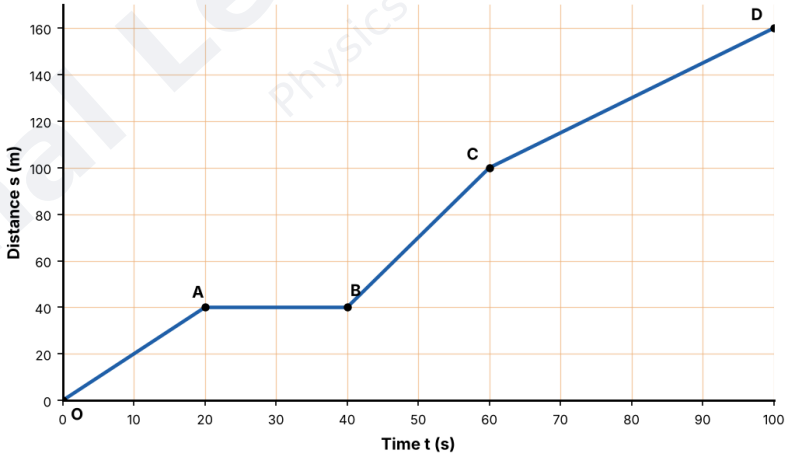
(a) Find the speed of the motorcyclist from the gradient.

(b) Find the distance covered after 5 s.

(c) Find the time taken to cover 42 m.

(d) Express the speed in km/h.

Figure 3: Distance-time graph of a boy walking



C2. (Figure 3, 5 marks)

Use Figure 3 (boy walking).

(a) Find the speed of the boy in parts OA, BC and CD.

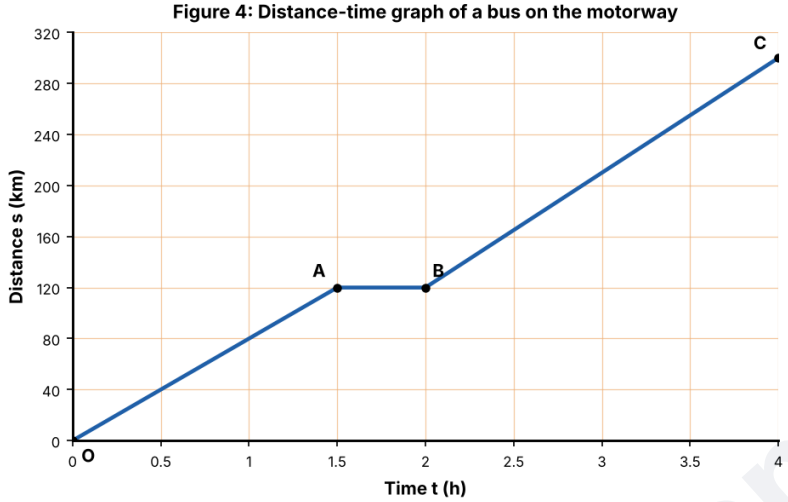
(b) For how long was the boy at rest?

(c) In which part was his speed greatest?

(d) Find the average speed for the whole journey.

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Figure 4: Distance-time graph of a bus on the motorway



C3. (Figure 4, 5 marks)

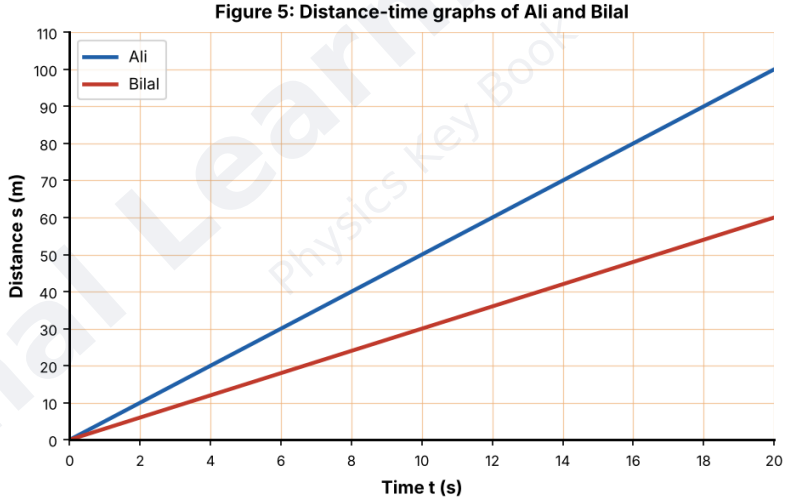
A bus travels on the motorway as shown in Figure 4. Find its speed in km/h and in m/s for:

(a) the journey from O to A,

(b) the journey from B to C,

(c) the whole journey from O to C.

Figure 5: Distance-time graphs of Ali and Bilal



C4. (Figure 5, 4 marks)

Use Figure 5 (Ali and Bilal).

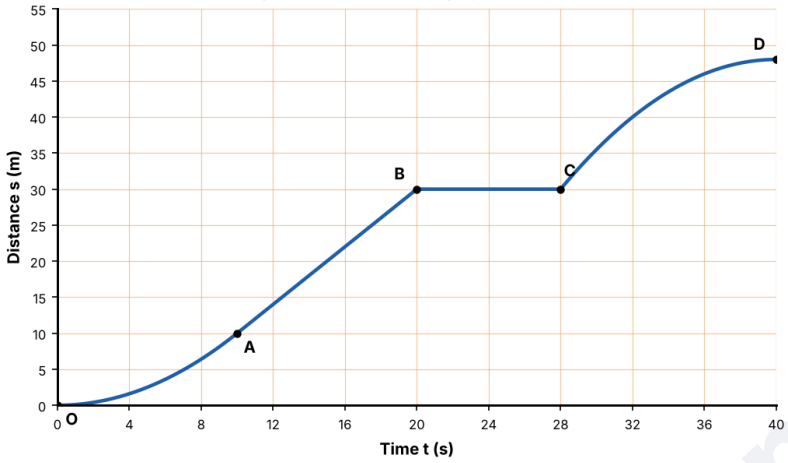
(a) Find the speed of each boy.

(b) Find the distance between them after 20 s.

(c) How long will Bilal take to cover 100 m?

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Figure 6: Distance-time graph of a toy car



C5. (Figure 6, 4 marks)

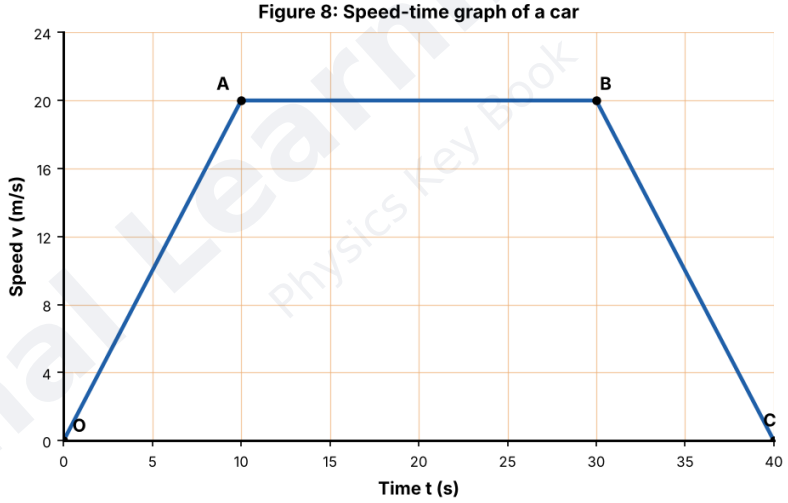
Use Figure 6 (toy car).

(a) Find the speed of the car in part AB.

(b) For how long is the car at rest?

(c) Find the average speed for the whole 40 s.

Figure 8: Speed-time graph of a car



C6. (Figure 8, 5 marks)

Use Figure 8 (car).

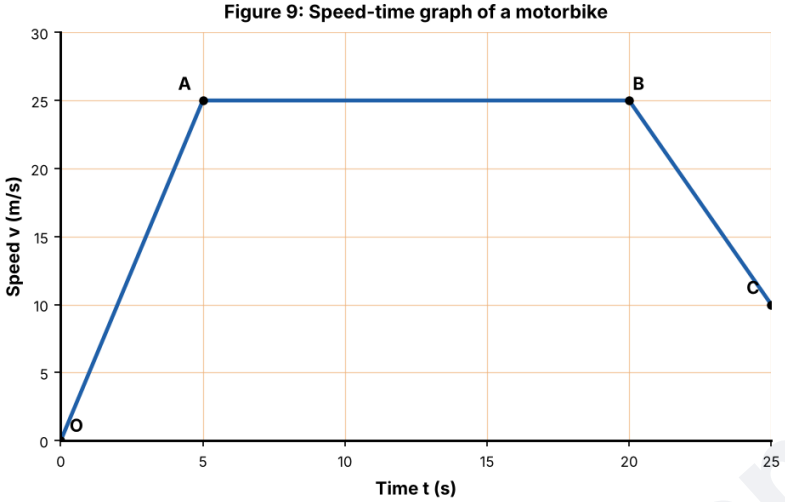
(a) Find the acceleration in the parts OA, AB and BC.

(b) Find the total distance covered using the area under the graph.

(c) Find the average speed of the car.

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Figure 9: Speed-time graph of a motorbike



C7. (Figure 9, 5 marks)

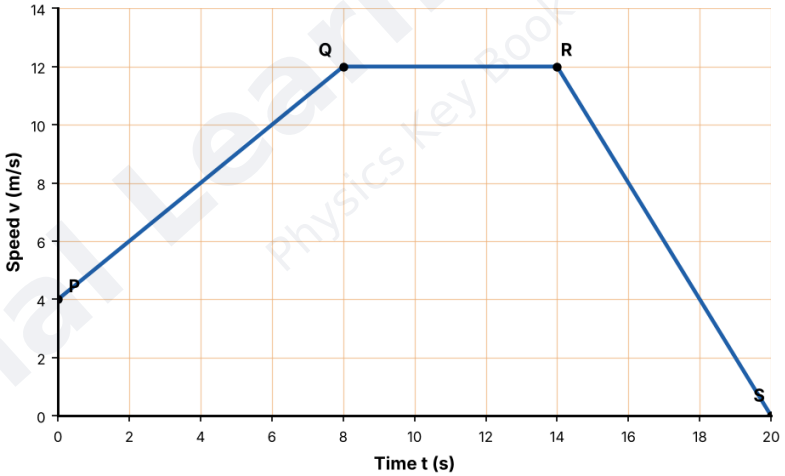
Use Figure 9 (motorbike).

(a) Calculate the acceleration in the parts OA, AB and BC.

(b) Calculate the total distance covered in 25 s.

(c) Calculate the average speed.

Figure 10: Speed-time graph of a cyclist



C8. (Figure 10, 5 marks)

A cyclist is already moving at 4 m/s at t = 0 s (Figure 10).

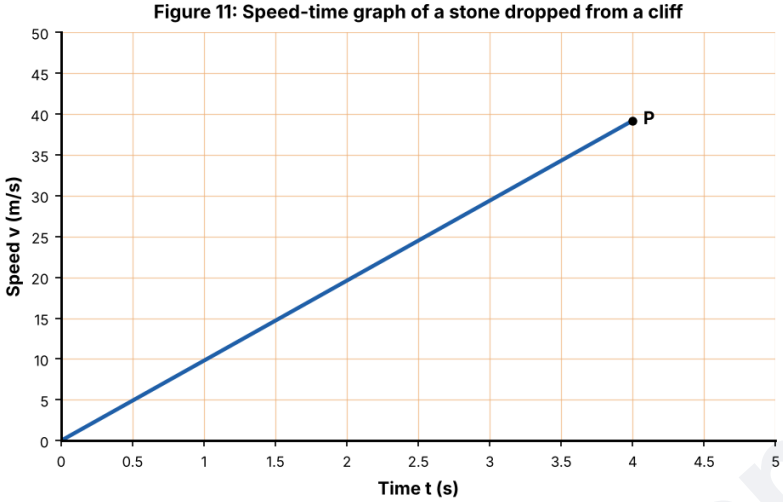
(a) Find the acceleration in the parts PQ, QR and RS.

(b) Find the total distance covered using the area under the graph (use the trapezium formula for PQ).

(c) Find the average speed.

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Figure 11: Speed-time graph of a stone dropped from a cliff



C9. (Figure 11, 4 marks)

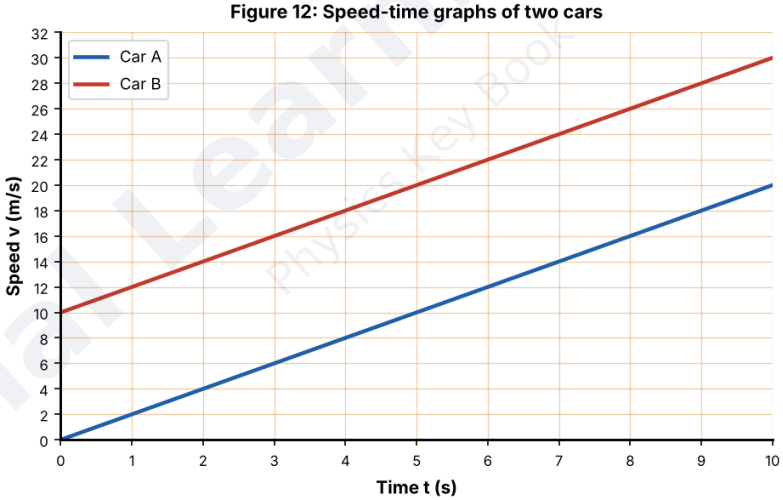
Use Figure 11 (stone dropped from a cliff).

(a) Find the gradient and state what it represents.

(b) Find the speed of the stone after 2 s.

(c) Find the distance fallen in 4 s.

Figure 12: Speed-time graphs of two cars



C10. (Figure 12, 5 marks)

Use Figure 12 (Car A and Car B).

(a) Find the acceleration of each car.

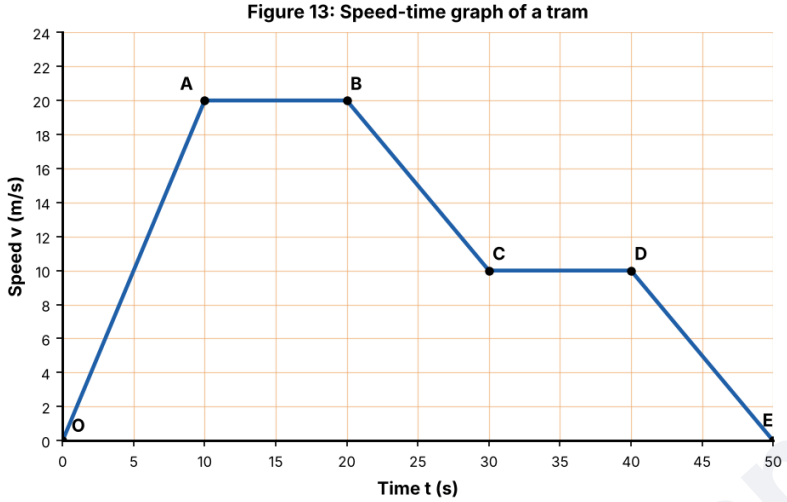
(b) Find the distance covered by each car in 10 s.

(c) Find the difference between the distances.

(d) Explain why Car B covers more distance although both have the same acceleration.

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Figure 13: Speed-time graph of a tram



C11. (Figure 13, 6 marks)

Use Figure 13 (tram).

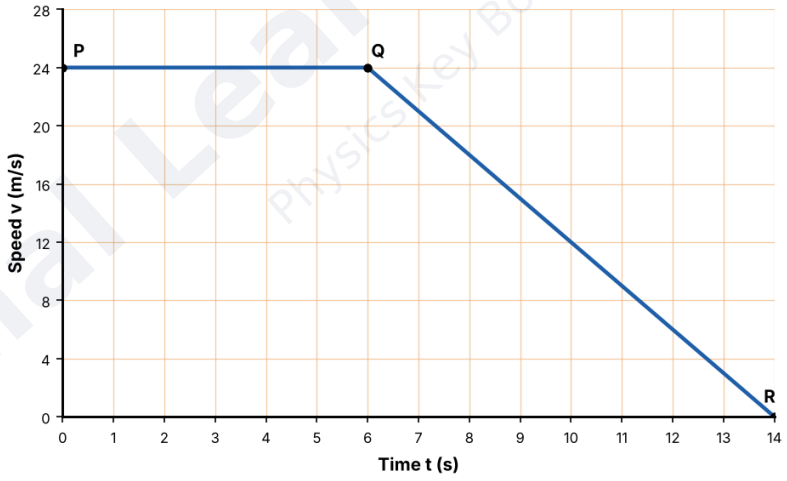
(a) Find the acceleration in each part: OA, AB, BC, CD and DE.

(b) Find the total distance covered.

(c) Find the average speed.

(d) In which parts is the tram decelerating?

Figure 14: Speed-time graph of a car that brakes



C12. (Figure 14, 5 marks)

A car is moving at 24 m/s. The driver sees an obstacle and brakes after a delay (Figure 14).

(a) How far does the car travel before the brakes are applied (P to Q)?

(b) Find the deceleration of the car.

(c) Find the braking distance (Q to R).

(d) Find the total distance and the average speed.

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PART D DRAW THE GRAPH QUESTIONS

Exam tip: Draw graphs on graph paper with a pencil. Label both axes with the quantity and its unit, choose a suitable scale, mark each plotted point, and join the points with a ruler (straight parts) or a smooth curve.

D1. (3 marks)

The table shows the distance covered by a cyclist.

Time t (s)	0	2	4	6	8	10
Distance s (m)	0	10	20	30	30	30

(a) Plot a distance-time graph (time on the x-axis, distance on the y-axis).

(b) Find the speed during the first 6 s.

(c) What does the cyclist do after 6 s?

D2. (4 marks)

The table shows the speed of a car at different times.

Time t (s)	0	5	10	20	25
Speed v (m/s)	0	10	20	20	0

(a) Plot a speed-time graph.

(b) Find the acceleration in 0 to 10 s, 10 s to 20 s and 20 s to 25 s.

(c) Find the total distance covered.

D3. (5 marks)

A train starts from rest and increases its speed uniformly to 30 m/s in 20 s. It then moves at this speed for 40 s. Then the brakes are applied and it stops uniformly in 10 s.

(a) Draw the speed-time graph.

(b) Find the acceleration in each part.

(c) Find the total distance using the area under the graph.

(d) Find the average speed.

D4. (4 marks)

A boy walks 60 m in 30 s at uniform speed. He then rests for 20 s. Then he runs 120 m in the next 20 s at uniform speed.

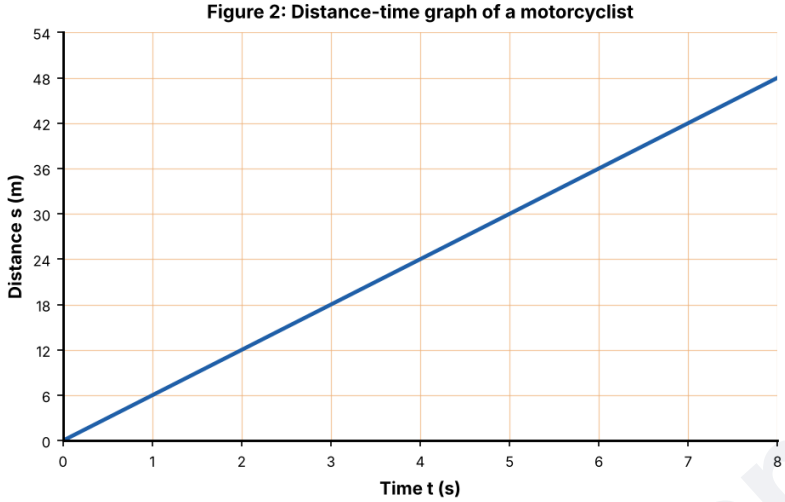
(a) Draw the distance-time graph for his journey.

(b) Find his speed in each part.

(c) Find his average speed for the whole journey.

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Figure 2: Distance-time graph of a motorcyclist



D5. (3 marks)

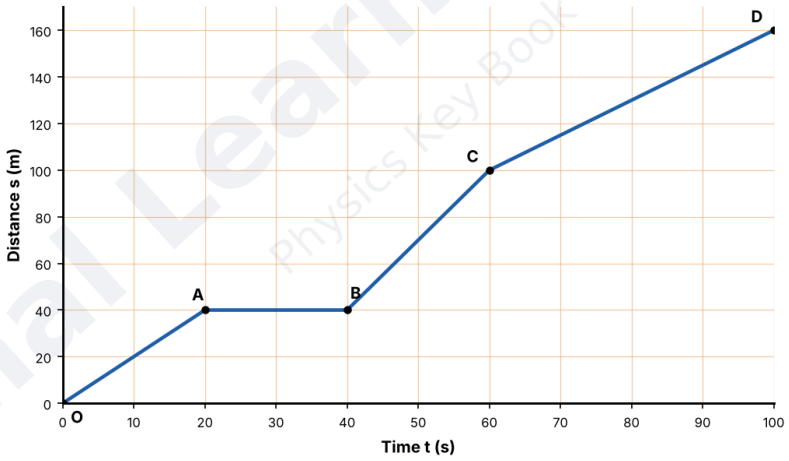
Use Figure 2.

(a) Draw the speed-time graph of the motorcyclist for 8 s.

(b) What kind of motion does your graph show?

(c) Show that the area under your graph equals the distance covered in 8 s.

Figure 3: Distance-time graph of a boy walking



D6. (4 marks)

Use the distance-time graph in Figure 3.

(a) Calculate the speed in each part of the journey.

(b) Draw the speed-time graph for the journey.

(c) Show that the area under your speed-time graph is equal to the total distance (160 m).

D7. (4 marks)

The speed of a freely falling stone is given by $v = g\,t$. Take $g = 9.8\ m/s^2$.

(a) Complete the table.

Time t (s)	0	1	2	3	4	5
Speed v (m/s)	0	?	?	?	?	?

(b) Plot the speed-time graph.

(c) Find the gradient and state what it represents.

(d) Find the distance fallen in 5 s from the area under the graph.

D8. (4 marks)

A car moves at 15 m/s for 20 s, then stays at rest for 10 s, then moves at 10 m/s for 30 s.

(a) Draw the distance-time graph.

(b) Find the total distance covered.

(c) Find the average speed for the whole journey.

D9. (5 marks)

A bike has a speed of 6 m/s. It increases its speed uniformly to 14 m/s in 8 s, moves at 14 m/s for 6 s, then decelerates uniformly to rest in 7 s.

(a) Draw the speed-time graph.

(b) Find the acceleration in each part.

(c) Find the total distance covered.

(d) Find the average speed.

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PART E THEORY QUESTIONS ON GRAPHS (LONG RESPONSE)

E1. (5 marks) Draw distance-time graphs for (a) a body at rest, (b) a body moving with uniform speed, (c) a body moving with increasing speed, and (d) a body moving with decreasing speed. Write one line of explanation for each.

E2. (5 marks) Draw speed-time graphs for (a) zero acceleration, (b) uniform acceleration and (c) uniform deceleration. Explain each using the slope.

E3. (5 marks) Show that the gradient of a distance-time graph gives the speed of the body. Explain the four steps for finding the gradient.

E4. (5 marks) Show that the area under a speed-time graph represents the distance covered by the body. Use a rectangular graph and a triangular graph.

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ANSWERS AND SOLUTIONS

Part A: MCQ answer key

Q	1	2	3	4	5	6	7	8	9	10
Ans	C	A	B	D	B	B	C	B	A	C

Q	11	12	13	14	15	16	17	18	19	20
Ans	A	B	D	C	C	B	C	B	C	B

Q	21	22	23	24	25
Ans	B	B	C	B	C

Reasons

Q	Reason
1	Horizontal line on a distance-time graph means the distance does not change: rest.
2	A straight rising line means equal distance in equal time: uniform speed.
3	A curve bending upward means the slope (speed) is increasing.
4	A curve bending downward means the slope (speed) is decreasing.
5	v = 48 ÷ 8 = 6 m/s.
6	AB is horizontal: distance does not change.
7	(100 − 40) ÷ (60 − 40) = 60 ÷ 20 = 3 m/s.
8	300 km ÷ 4 h = 75 km/h.
9	Ali's line is steeper, so his gradient (speed) is greater (5 m/s against 3 m/s).
10	BC is horizontal: the distance does not change, so the car is at rest.
11	Horizontal line on a speed-time graph: speed does not change, so a = 0.
12	Straight rising line: speed changes by equal amounts in equal time.
13	Straight falling line: uniform deceleration (negative slope).
14	Curved line: the slope keeps changing, so the acceleration is not uniform.
15	a = (20 − 0) ÷ 10 = 2 m/s².
16	Rectangle: 20 × 20 = 400 m.
17	Rectangle: 25 × 15 = 375 m.
18	The graph starts at 4 m/s on the speed axis.
19	Slope = 39.2 ÷ 4 = 9.8 m/s², the acceleration due to gravity.
20	Area = ½ × 4 × 39.2 = 78.4 m.
21	Equal slopes mean equal acceleration.
22	AB and CD are horizontal lines: the speed is constant, so a = 0.
23	a = (0 − 24) ÷ (14 − 6) = −3 m/s².
24	Distance never decreases with time, so the slope (speed) cannot be negative.

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Q	Reason
25	Area under a speed-time graph = distance travelled.

Part B: Short response answers

Q	Answer
B1	**A:** straight rising line, constant slope, so uniform speed. **B:** curve bending upward, slope increasing, so increasing speed. **C:** horizontal line, zero slope, so the body is at rest. **D:** curve bending downward, slope decreasing, so decreasing speed.
B2	Distance stays at 40 m while time passes, so the boy is at rest (speed = 0) for 20 s.
B3	Ali is faster. His line is steeper, so his gradient (speed) is greater. Ali: 100 ÷ 20 = 5 m/s. Bilal: 60 ÷ 20 = 3 m/s.
B4	**OA:** curve bending upward, so the speed is increasing. **AB:** straight line, uniform speed of (30 − 10) ÷ (20 − 10) = 2 m/s. **BC:** horizontal line, so the car is at rest (for 8 s). **CD:** curve bending downward, so the speed is decreasing.
B5	**P:** slope is zero, so acceleration is zero (uniform speed). **Q:** constant positive slope, so uniform acceleration. **R:** slope keeps increasing, so non-uniform (increasing) acceleration. **S:** constant negative slope, so uniform deceleration.
B6	The slopes are equal, so both cars have the same acceleration (2 m/s²). Car B covers more distance because its speed is 10 m/s greater than Car A at every instant (Car A: 100 m, Car B: 200 m).
B7	The speed is decreasing uniformly: the car is decelerating at 3 m/s² until it stops.
B8	A downward slope would mean negative speed, i.e. distance decreasing. Distance is the total path length and can never decrease, so the graph can only rise or stay horizontal.
B9	The acceleration is zero and the body is moving with uniform (constant) speed.
B10	The speed is zero at all times: the body is at rest.
B11	Slope of a distance-time graph = Δs ÷ Δt and gives **speed** (m/s). Slope of a speed-time graph = Δv ÷ Δt and gives **acceleration** (m/s²).
B12	Distance = area of the rectangle = **v × t** (speed multiplied by time).
B13	Speed-time graph: a horizontal line parallel to the time axis. Distance-time graph: a straight sloping line (not horizontal). A horizontal line on the distance-time graph means rest.
B14	The slope is increasing, so the speed of the body is increasing (the body is accelerating).

Part C: Numerical solutions

C1. Figure 2

	Find	Working	Answer
a	Speed	v = Δs ÷ Δt = 48 ÷ 8	**6 m/s**
b	Distance at 5 s	s = v t = 6 × 5	**30 m**
c	Time to cover 42 m	t = s ÷ v = 42 ÷ 6	**7 s**
d	Speed in km/h	6 × 3.6	**21.6 km/h**

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C2. Figure 3

	Find	Working	Answer
a	Speed in OA	(40 − 0) ÷ (20 − 0) = 40 ÷ 20	**2 m/s**
	Speed in BC	(100 − 40) ÷ (60 − 40) = 60 ÷ 20	**3 m/s**
	Speed in CD	(160 − 100) ÷ (100 − 60) = 60 ÷ 40	**1.5 m/s**
b	Time at rest	AB: 40 s − 20 s	**20 s**
c	Greatest speed	Compare 2, 3 and 1.5 m/s	**BC (3 m/s)**
d	Average speed	Total distance ÷ total time = 160 ÷ 100	**1.6 m/s**

C3. Figure 4

	Find	Working	Answer
a	O to A	120 ÷ 1.5 = 80 km/h; 80 ÷ 3.6	**80 km/h = 22.22 m/s**
b	B to C	(300 − 120) ÷ (4 − 2) = 180 ÷ 2 = 90 km/h; 90 ÷ 3.6	**90 km/h = 25 m/s**
c	Whole journey	300 ÷ 4 = 75 km/h; 75 ÷ 3.6	**75 km/h = 20.83 m/s**

C4. Figure 5

	Find	Working	Answer
a	Speed of Ali	100 ÷ 20	**5 m/s**
	Speed of Bilal	60 ÷ 20	**3 m/s**
b	Distance between them	100 − 60	**40 m**
c	Time for Bilal to cover 100 m	t = s ÷ v = 100 ÷ 3	**33.3 s**

C5. Figure 6

	Find	Working	Answer
a	Speed in AB	(30 − 10) ÷ (20 − 10) = 20 ÷ 10	**2 m/s**
b	Time at rest	BC: 28 s − 20 s	**8 s**
c	Average speed	Total distance ÷ total time = 48 ÷ 40	**1.2 m/s**

C6. Figure 8

	Find	Working	Answer
a	Acceleration in OA	(20 − 0) ÷ 10	**2 m/s²**
	Acceleration in AB	(20 − 20) ÷ 20	**0 m/s²**
	Acceleration in BC	(0 − 20) ÷ 10	**−2 m/s²**
b	Total distance	Triangle OA: ½ × 10 × 20 = 100 m; rectangle AB: 20 × 20 = 400 m; triangle BC: ½ × 10 × 20 = 100 m	**600 m**
c	Average speed	600 ÷ 40	**15 m/s**

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C7. Figure 9

	Find	Working	Answer
a	Acceleration in OA	(25 − 0) ÷ 5	**5 m/s²**
	Acceleration in AB	(25 − 25) ÷ 15	**0 m/s²**
	Acceleration in BC	(10 − 25) ÷ 5	**−3 m/s²**
b	Total distance	OA: ½ × 5 × 25 = 62.5 m; AB: 15 × 25 = 375 m; BC: ½ × (25 + 10) × 5 = 87.5 m	**525 m**
c	Average speed	525 ÷ 25	**21 m/s**

C8. Figure 10

	Find	Working	Answer
a	Acceleration in PQ	(12 − 4) ÷ 8	**1 m/s²**
	Acceleration in QR	(12 − 12) ÷ 6	**0 m/s²**
	Acceleration in RS	(0 − 12) ÷ 6	**−2 m/s²**
b	Total distance	PQ: ½ × (4 + 12) × 8 = 64 m; QR: 12 × 6 = 72 m; RS: ½ × 6 × 12 = 36 m	**172 m**
c	Average speed	172 ÷ 20	**8.6 m/s**

C9. Figure 11

	Find	Working	Answer
a	Gradient	39.2 ÷ 4 (acceleration due to gravity, g)	**9.8 m/s²**
b	Speed after 2 s	v = g t = 9.8 × 2	**19.6 m/s**
c	Distance fallen in 4 s	½ × 4 × 39.2	**78.4 m**

C10. Figure 12

	Find	Working	Answer
a	Acceleration of Car A	(20 − 0) ÷ 10	**2 m/s²**
	Acceleration of Car B	(30 − 10) ÷ 10	**2 m/s²**
b	Distance by Car A	½ × 10 × 20	**100 m**
	Distance by Car B	½ × (10 + 30) × 10	**200 m**
c	Difference	200 − 100	**100 m**
d	Reason	Car B starts at 10 m/s but Car A starts from rest. The same acceleration gives the same change in speed, but Car B is faster at every instant.	**Car B covers more distance**

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C11. Figure 13

	Find	Working	Answer
a	Acceleration in OA	20 ÷ 10	**2 m/s²**
	in AB and CD	Speed constant	**0 m/s²**
	in BC	(10 − 20) ÷ 10	**−1 m/s²**
	in DE	(0 − 10) ÷ 10	**−1 m/s²**
b	Total distance	OA: ½ × 10 × 20 = 100 m; AB: 10 × 20 = 200 m; BC: ½ × (20 + 10) × 10 = 150 m; CD: 10 × 10 = 100 m; DE: ½ × 10 × 10 = 50 m	**600 m**
c	Average speed	600 ÷ 50	**12 m/s**
d	Decelerating parts	Negative slope	**BC and DE**

C12. Figure 14

	Find	Working	Answer
a	Distance P to Q	24 × 6	**144 m**
b	Deceleration	(0 − 24) ÷ (14 − 6) = −24 ÷ 8	**−3 m/s² (deceleration 3 m/s²)**
c	Braking distance Q to R	½ × 8 × 24	**96 m**
d	Total distance	144 + 96	**240 m**
	Average speed	240 ÷ 14	**17.14 m/s**

Part D: Draw the graph answers

D1

	Find	Working	Answer
a	Plot	Points (0, 0), (2, 10), (4, 20), (6, 30), (8, 30), (10, 30): a rising straight line up to 6 s, then a horizontal line	**Graph**
b	Speed in first 6 s	30 ÷ 6	**5 m/s**
c	After 6 s	Distance stays 30 m	**At rest**

D2

	Find	Working	Answer
a	Plot	Points (0, 0), (10, 20), (20, 20), (25, 0); the point (5, 10) lies on the first line	**Graph**
b	Acceleration 0 to 10 s	20 ÷ 10	**2 m/s²**
	10 s to 20 s	Speed constant	**0 m/s²**
	20 s to 25 s	(0 − 20) ÷ 5	**−4 m/s²**
c	Total distance	½ × 10 × 20 = 100 m; 10 × 20 = 200 m; ½ × 5 × 20 = 50 m	**350 m**

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D3

	Find	Working	Answer
a	Plot	Points (0, 0), (20, 30), (60, 30), (70, 0)	**Graph**
b	Acceleration, 1st part	30 ÷ 20	**1.5 m/s²**
	2nd part	Speed constant	**0 m/s²**
	3rd part	(0 − 30) ÷ 10	**−3 m/s²**
c	Total distance	½ × 20 × 30 = 300 m; 40 × 30 = 1200 m; ½ × 10 × 30 = 150 m	**1650 m**
d	Average speed	1650 ÷ 70	**23.57 m/s**

D4

	Find	Working	Answer
a	Plot	Points (0, 0), (30, 60), (50, 60), (70, 180): a sloping line, a horizontal line, then a steeper sloping line	**Graph**
b	Walking speed	60 ÷ 30	**2 m/s**
	Resting	No change in distance	**0 m/s**
	Running speed	120 ÷ 20	**6 m/s**
c	Average speed	Total distance 60 + 0 + 120 = 180 m; 180 ÷ 70	**2.57 m/s**

D5

	Find	Working	Answer
a	Plot	A horizontal line at 6 m/s from t = 0 to t = 8 s	**Graph**
b	Type of motion	Speed does not change	**Uniform speed, zero acceleration**
c	Area under graph	v × t = 6 × 8 (equals the distance in Figure 2)	**48 m**

D6

	Find	Working	Answer
a	Speeds from Figure 3	OA: 2 m/s; AB: 0 m/s; BC: 3 m/s; CD: 1.5 m/s	**Speeds**
b	Plot	Horizontal lines at 2 m/s (0 to 20 s), 0 m/s (20 to 40 s), 3 m/s (40 to 60 s) and 1.5 m/s (60 to 100 s)	**Graph**
c	Area under graph	2 × 20 + 0 + 3 × 20 + 1.5 × 40 = 40 + 0 + 60 + 60	**160 m**

D7

	Find	Working	Answer
a	Speeds	v = g t = 9.8 × t for t = 1, 2, 3, 4, 5 s	**9.8, 19.6, 29.4, 39.2, 49.0 m/s**
b	Plot	Straight line from (0, 0) to (5, 49)	**Graph**
c	Gradient	49 ÷ 5 (acceleration due to gravity, g)	**9.8 m/s²**
d	Distance in 5 s	½ × 5 × 49	**122.5 m**

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D8

	Find	Working	Answer
a	Plot	Points (0, 0), (20, 300), (30, 300), (60, 600)	**Graph**
b	Total distance	15 × 20 = 300 m; rest = 0 m; 10 × 30 = 300 m	**600 m**
c	Average speed	600 ÷ 60	**10 m/s**

D9

	Find	Working	Answer
a	Plot	Points (0, 6), (8, 14), (14, 14), (21, 0)	**Graph**
b	Acceleration, 1st part	(14 − 6) ÷ 8	**1 m/s²**
	2nd part	Speed constant	**0 m/s²**
	3rd part	(0 − 14) ÷ 7	**−2 m/s²**
c	Total distance	½ × (6 + 14) × 8 = 80 m; 14 × 6 = 84 m; ½ × 7 × 14 = 49 m	**213 m**
d	Average speed	213 ÷ 21	**10.14 m/s**

Part E: Model answer points

Q	Answer
E1	**Rest:** horizontal line (distance does not change with time, slope = 0). **Uniform speed:** straight rising line (constant slope). **Increasing speed:** curve bending upward (slope increasing). **Decreasing speed:** curve bending downward (slope decreasing).
E2	**Zero acceleration:** horizontal line parallel to the time axis (slope = 0). **Uniform acceleration:** straight rising line (constant positive slope). **Uniform deceleration:** straight falling line (constant negative slope).
E3	**Step 1:** choose two points Pi (ti, si) and Pf (tf, sf) on the graph. **Step 2:** draw perpendiculars on both axes to read the coordinates. **Step 3:** find Δt = tf − ti and Δs = sf − si. **Step 4:** gradient = Δs ÷ Δt. This is the definition of speed, so gradient = v.
E4	**Rectangle (uniform speed):** area = width × length = v × t, and s = v t, so area = distance. **Triangle (speed rising uniformly from zero):** area = ½ × v × t, and s = ½ v t, so area = distance. Hence the area under a speed-time graph represents the distance travelled.

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