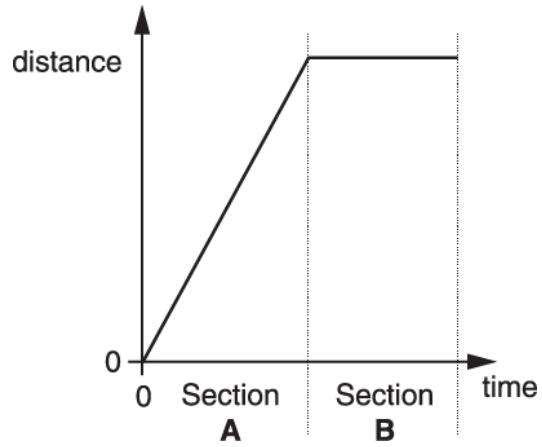1(a). Lorries are fitted with tachometers that automatically record their speed and distance travelled.

The data from the tachometer is used to produce graphs.

This graph shows the distance-time graph for part of a journey.

How is the lorry moving during sections **A** and **B** of its journey?

Draw one straight line from each **section** to its correct **motion**.

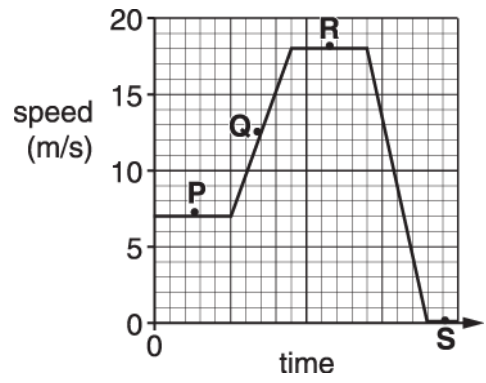| Section		Motion
		moving at constant speed
A		slowing down
B		speeding up
		not moving

[2]

(b). This graph shows the **speed-time** graph for part of another journey.

(i) What is the maximum speed of the lorry shown on the graph?

maximum speed = _____ m/s **[1]**

(ii) At which point on the graph is the lorry not moving?

Put a (ring) around the correct answer.

P   Q   R   S

[1]

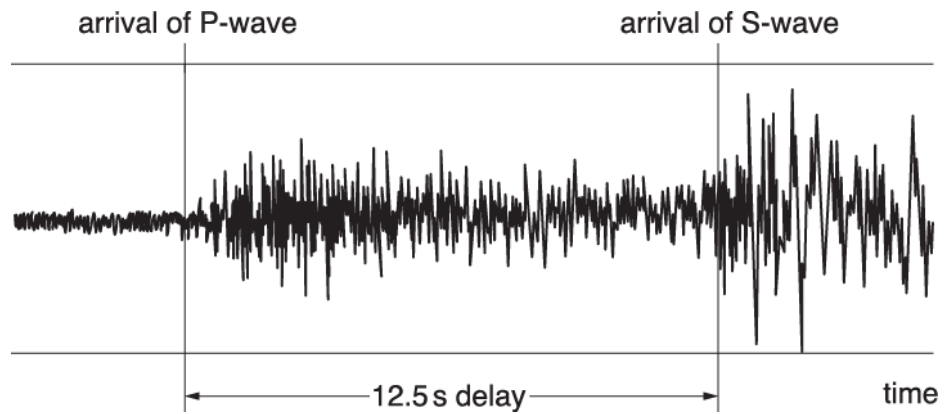2. An earthquake happened 100 km away from town **A**.

The earthquake produced two types of wave, P-waves and S-waves.

The P-waves arrived at town **A** 12.5 s later.

(i) Calculate the speed of the P-waves.

speed = _____ km / s **[1]**

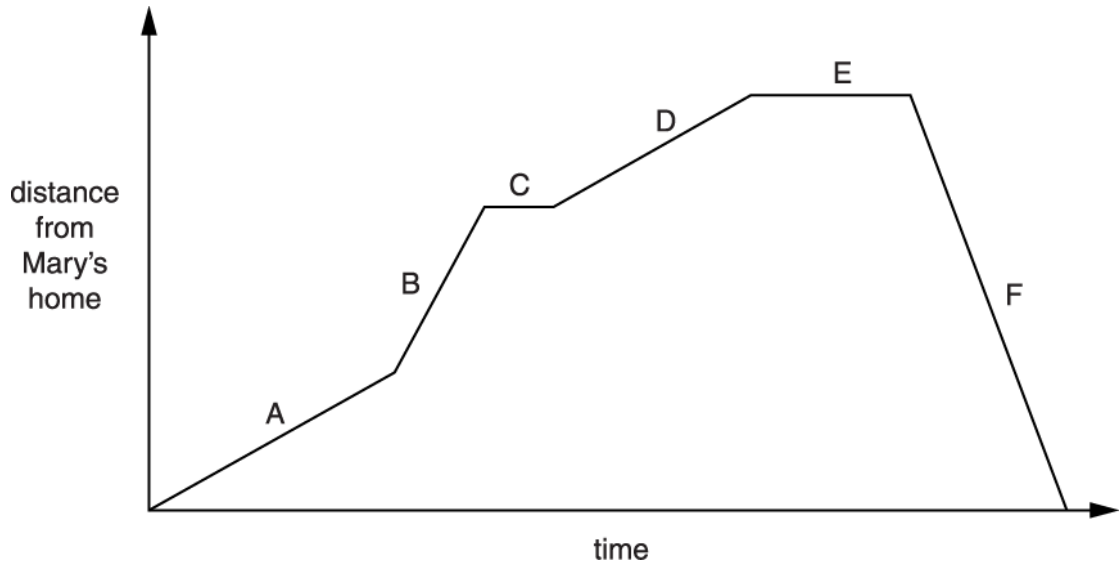The diagram shows the earthquake detector trace in town **A**.

(ii) Calculate the speed of the S-waves.
Show your working.

speed = _____ km / s **[2]**

3. Mary went on a journey. This is the distance-time graph for her journey.

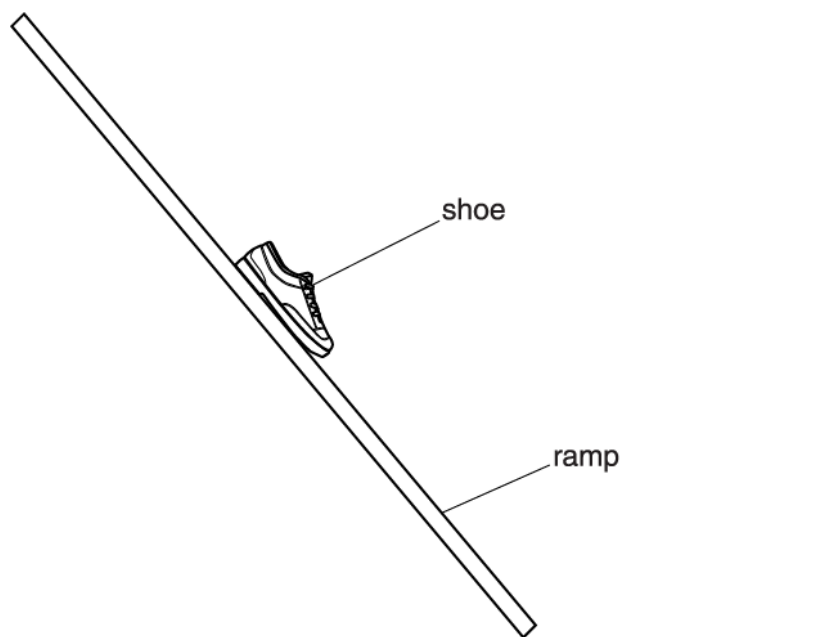Use the graph to describe Mary's journey.

The quality of written communication will be assessed in your answer.

---[6]

4. Ross is doing an experiment with shoes.

He places a shoe at the top of a ramp and measures the time it takes the shoe to slide down the ramp.

Ross has four different size shoes.

He does the experiment three times with each shoe.

Here are his results.

Shoe size	Time to slide down the ramp in seconds		
	Test 1	Test 2	Test 3
5	0.9	1.0	1.0
7	1.3	1.2	1.1
9	1.4	1.5	1.4
11	1.6	1.6	1.7

Ross measured the distance the shoes slide down the ramp to be 1.8 m.

Calculate the average speed of the **size 7** shoe down the ramp, and write down the unit.

Show your working.

speed = _ _ _ _ _ _ _ _ _ _ _ _ _ unit _ _ _ _ _ _ _ _ _ _ _ _ _ **[3]**

5(a). Racing car teams track the progress of cars to analyse their performance.

One team was testing how well a car accelerated at the start of a race.

The car accelerated from rest to 40 m/s in 4 seconds.

What was the average acceleration of the car?
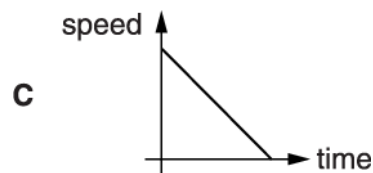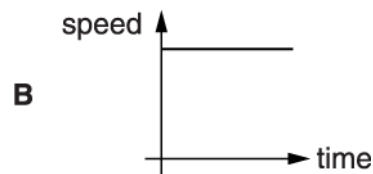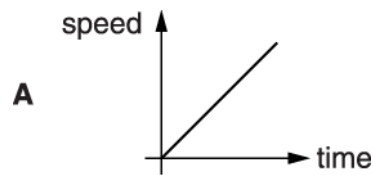
Put a (ring) around the correct answer.

0.1 m/s^2 $\qquad$ 10 m/s^2 $\qquad$ 36 m/s^2 $\qquad$ 44 m/s^2

[1]

(b). The team use their measurements to plot a speed-time graph for the car.
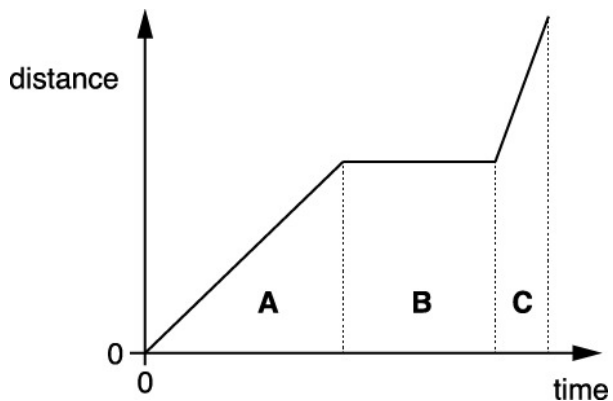
Which speed-time graph, **A**, **B**, or **C**, shows the car accelerating?

graph _____ [1]

6(a). Alex goes for a ride on his bike.

The graph shows how his distance from the start of his ride changes with time.

The graph has been divided into three regions **A**, **B** and **C**.

Which region or regions show each type of motion?

Put ticks (✓) in the correct box or boxes for each row.

You may tick more than one box in a row.

Type of motion	Region		
	A	B	C
Stationary			
Moving with constant speed			
Fastest speed			

[3]

(b). On his return ride, Alex:

- accelerates from rest from 0 to 2 minutes
- then rides at constant speed from 2 to 8 minutes
- and finally slows down and comes to rest at 11 minutes.

On the sketch graph below show how Alex's **speed** changes with time during his return ride.
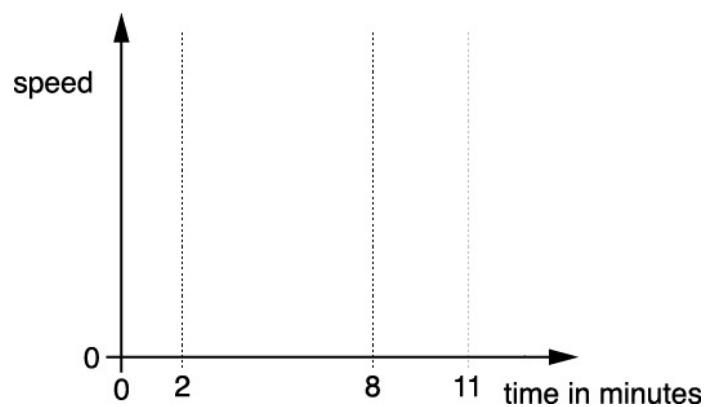
[3]

7.   This question is about earthquakes in Turkey.

P-waves travel at 8000 m/s from a small earthquake in Usak in Turkey. They are detected in Bursa 21 seconds later.

Calculate the distance from Usak to Bursa.

distance = ----------------------m [2]

8. A car travels along a straight horizontal road.

   The table shows how the speed of the car varies for part of its journey.

Time (s)	0	10	20	30	40	50	60	70	80
Speed (m/s)	20	20	20	20	22	24	26	28	30

   Use the data in the table to describe and explain the motion of the car.

   You may draw a **sketch** graph with important points clearly labelled to help you answer the question.

   The quality of written communication will be assessed in your answer.

   -- **[6]**

   [Total: 6]

9(a). Alex is planning his journey to school.

Alex usually walks to school.

Which is the most likely speed at which Alex walks?

Put a (ring) around the correct answer.

| 0.12 m/s | 1.2 m/s | 12 m/s | 120 m/s |

[1]

(b). He could travel by car.

A car travels at 36 km/h (kilometres per hour).

Which is the correct calculation to work out this speed in m/s (metres per second)?
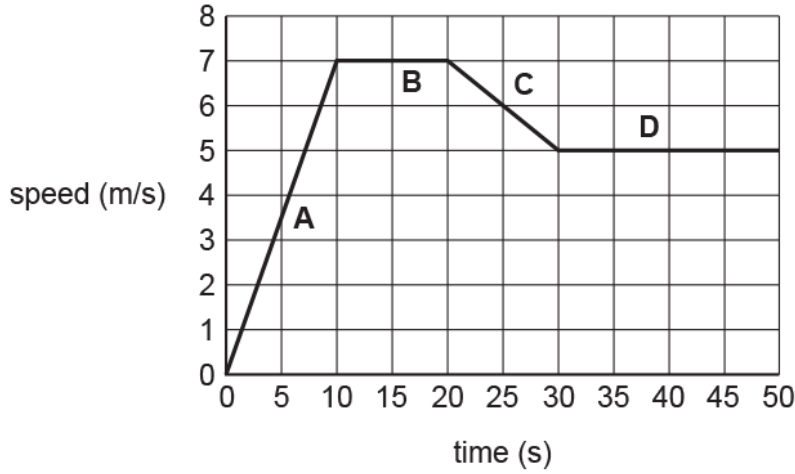
Put a (ring) around the correct answer.

$$\frac{36 \times 60}{1000} \qquad \frac{36 \times 1000}{60} \qquad \frac{36 \times 3600}{1000} \qquad \frac{36 \times 1000}{3600}$$

[1]

(c). In the end Alex decides to cycle to school.

The graph shows the first part of this journey.

speed (m/s)

time (s)

(i) Put a tick (✓) in the **one** correct box in each row.

	A	B	C	D
In which section does Alex have an average speed of 3.5 m/s?				
In which section does Alex slow down?				

[2]

(ii) Calculate the acceleration in section **A** of the journey.

Use the equation: acceleration = change in speed ÷ time

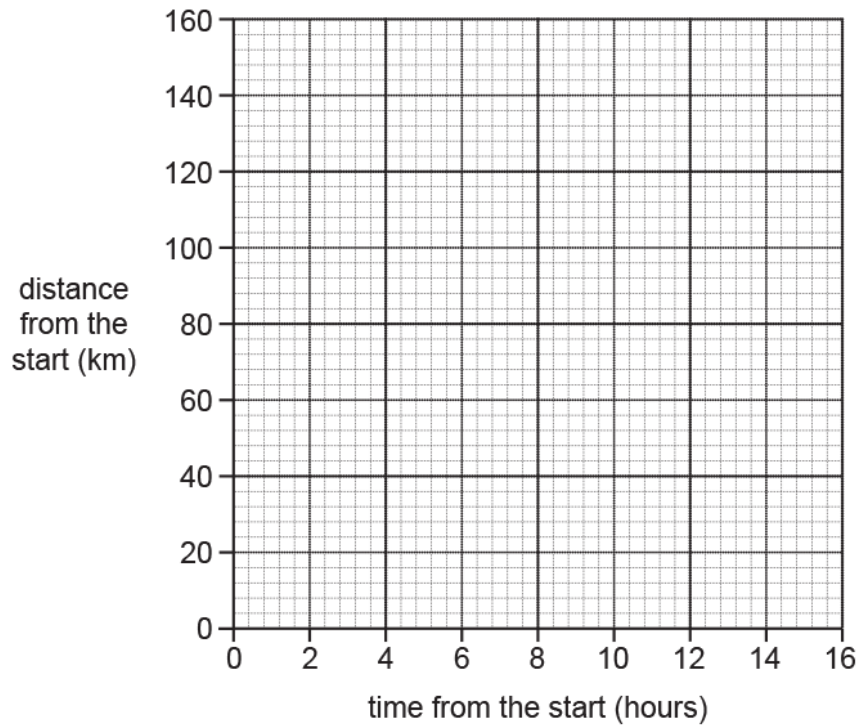Acceleration = ... m/s^2[3]

10. There is a film about an astronaut named Mark Watney. He is left alone on the planet Mars. He has to use science to stay alive until he can be rescued.

To be rescued, Watney needs to travel 3200 km across Mars to a rocket. Watney sets off on his journey to the rocket.

He drives for 4 hours at a steady speed of 25 km/hour.

He then stops to let the battery re-charge for 10 hours.

Complete this distance-time graph.

[4]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		Moving at a constant speed — A slowing down speeding up B — Not moving	2	One mark for each correct line **Examiner's Comments** This question was generally answered very well. Most candidates used the correct number of lines and many of them correctly identified the motion of the lorry from the graph.
	b	i	18 (m/s)	1	**Examiner's Comments** This was answered very well by almost all candidates. A few gave 15.6 as an incorrect reading from the graph.
		ii	S (4ᵗʰ answer)	1	**Examiner's Comments** Again this question was answered very well and the vast majority of candidates scored the mark.
			Total	**4**	
2		i	Speed = 8 (km/s)	1	**Examiner's Comments** At least half of the candidates did not show their calculation. There were lots of answers of 1250 km/s and evidence of candidates changing their mind between 8 km/s and 1250 km/s. Answer = 8 km/s
		ii	Time is 12.5s + 12.5s = 25s (1); Speed = 100 km / 25s = 4 (km/s) (1)	2	4 km/s without working = 2 marks 8 km/s = 1 mark **Examiner's Comments** Few candidates could do this part and few showed their calculation. Some used a time of 12.5s and scored 1 mark for the speed calculation. Answer = 4 km/s
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
3			**(Level 3)** Correctly identifies sections with different speeds and directions as well as sections with no motion within their narrative. Quality of written communication does not impede communication of the science at this level. (5–6 marks) **(Level 2)** Correctly identifies sections with different speeds or directions as well as sections with no motion within their narrative. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) **(Level 1)** Correctly identifies a section where she is moving and a section with no motion within their narrative. Quality of written communication impedes communication of the science at this level. (1–2 marks) **(Level 0)** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to E **Ignore** references to mode of transport used in the journey Indicative scientific points may include: • no motion at C and E • moving away from home at A, B and D • moving towards home at F • ends up back where she started • B and F are faster motion than D or E Use the L1, L2, L3 annotations in Scoris; **do not use ticks.** <u>Examiner's Comments</u> This extended writing question equired candidates to interpret a distance-time graph. It was good to find that the majority of andidates were able to earn full marks by correctly identifying the relative speed and direction of the subject. It was noticeable that a significant minority of candidates lost many marks by assuming a speed-time graph instead of a distance-time one.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
4			mean time calculated (1.3 + 1.2 + 1.1) / 3 **or** 1.2 (1) speed calculated = 1.5 (1) m/s (1)	3	**NOT** if either is incorrect **allow** an average of the speeds (1) **but** 1.5 gets 2 marks if no working is shown **allow** ecf calculated from 1.8 ÷ their mean time (1) **NOT** mps **allow** ms$^{?1}$ or 'metres per second' (1) **Examiner's Comments** This question was about the relationship between shoe size and slide-time along a ramp. Candidates were expected to interpret and evaluate data and draw conclusions using the available evidence. Overall this question differentiated well. Most candidates showed evidence of calculating the average time. A common error however was to assume that this was the speed. Hence the distance measurement given was ignored by a significant number of candidates. A majority of responses were unable to determine the unit in the conventionally written way while a minority showed clear uncertainty as to the meaning of the term 'unit' in this context.
			Total	3	
5	a		10 m/s^2	1	**Examiner's Comments** This question was answered correctly by the vast majority of candidates.
	b		A	1	**Examiner's Comments** This question was answered correctly by the majority of candidates.
			Total	2	

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	Question		Answer/Indicative content	Marks	Guidance
6	a		<table><tr><td></td><td colspan="3">**Region**</td></tr><tr><td>**Type of Motion**</td><td>**A**</td><td>**B**</td><td>**C**</td></tr><tr><td>stationary</td><td></td><td>√</td><td></td></tr><tr><td>moving with constant speed</td><td>√</td><td></td><td>√</td></tr><tr><td>fastest speed</td><td></td><td></td><td>√</td></tr></table>	3	One mark for each row **Examiner's Comments** Most candidates scored at least half of the marks in this question about a bike ride. Most candidates ignored the instruction that they could put more than one tick in each row, this led to the majority of candidates earning only two marks.
	b		0 – 2min: starts at 0 and positive slope (1); 2 – 8min: **horizontal** line (1); 8 – 11min: negative slope to 0 (1)	3	**allow** straight or curved line **allow** line drawn freehand **allow** straight or curved line **Examiner's Comments** Most candidates scored at least half of the marks in this question about a bike ride. The speed-time graph proved to be straightforward for strong candidates, although many did not draw a horizontal line for the central section where the speed was constant. Many weak candidates seemed to be drawing a distance-time graph instead.
			Total	6	
7			FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 168 000 (m) award 2 marks. distance = 8000 (m/s) × 21 (s) (1); = 168 000 (m) (1)	2	
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
8			**[Level 3]** Describes both sections of the journey and explains one using data **OR** clear forces argument Quality of written communication does not impede communication of the science at this level. (5–6 marks) **[Level 2]** Describes both sections of the journey. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) **[Level 1]** Describes one section of the journey. Quality of written communication impedes communication of the science at this level. (1–2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to C Indicative scientific points may include: Describe motion: • constant speed at the start • acceleration / speeding up Explanation / Justification: • Uses data from table to explain description eg constant speed is until 30 seconds • Acceleration from 30-80 seconds. • Acceleration is 2m/s every 10 seconds • Forces arguments • constant speed due to balanced forces • acceleration due to unbalanced / resultant force • driving and counter (air resist/friction) forces • at const speed driving fore = counter force • when accelerating driving force > counter Look for points next to table and sketch graph L2 can be gained from sketching correct graph. **Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.**
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9	a		1.2 m/s ✓	1 (AO 1.1)	0.12 m/s ⬭1.2 m/s⬭ 12 m/s 120 m/s
	b		$\dfrac{36 \times 1000}{3600}$ ✓	1 (AO 2.1)	$\dfrac{36 \times 60}{1000}$ $\dfrac{36 \times 1000}{60}$ $\dfrac{36 \times 3600}{1000}$ ⬭$\dfrac{36 \times 1000}{3600}$⬭ **Examiner's Comments** Some candidates showed some rough working in order to work out which calculation was correct, as it was clearly confusing for some of them. There was no common incorrect choice.
	c	i	<table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>In which section does Sam have an average speed of 3.5 m/s?</td><td>✓</td><td></td><td></td><td></td></tr><tr><td>In which section does Sam slow down?</td><td></td><td></td><td>✓</td><td></td></tr></table>	2 (AO 2.2) (AO 1.2)	
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.7 (m/s²) award 3 marks** Reading off the graph: change in speed = (7 (m/s) – 0) ✓ 7(m/s) ÷ 10 (s) ✓ = 0.7 (m/s²) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** just 7 and/or just 10 for first marking point. **ALLOW** use of any data points from section A of graph eg 3.5 ÷ 5. **Examiner's Comments** Most candidates were able to read appropriate data from the graph in order to calculate acceleration. Most used the change in speed as 7 m/s and the time as 10s, but some used a change of speed of 3.5 m/s and a time of 5 s, showing good understanding of the speed-time graph.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
10			25 (km/h) × 4 (h) = 100 (km) ✓ Straight diagonal line from [0,0] ✓ Stopping at [100,4] ✓ horizontal line from [100,4] to [100,14] ✓	4 (AO 1.2) (AO 2.2 ×3)	May be shown by the correct graph **ALLOW** ECF from mp3 <u>Examiner's Comments</u> Some candidates plotted (4, 25) instead of (4, 100). Another common mistake was to continue the graph after (14,100) with a diagonal line either up or down.
			Total	4	