VELOCITY-TIME GRAPHS

GRADE 9

AtoZrevision

Examination Practice Questions

You should have:

A ruler, protractor, compasses, a pen, pencil, eraser, calculator.
For some questions, you may need tracing paper.

Instructions

- Use **black** ink or ball-point pen.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Calculators may be used.**

Information

- The marks for each question are shown in brackets.
- Use the number of marks for each question as a guide as to how much time to spend on each question. As a rough guide, you can multiply the number of marks by 1.2 to see how many minutes you should spend on a question.
- Questions been carefully compiled from or modelled on a variety of past papers and will generally get more challenging as the document progresses. Some of the later questions will go beyond the core grade level for this topic.

Advice

- Read each question carefully before you start to answer it.
- Don't forget to have fun.
- Check your answers at the end.

Q1.

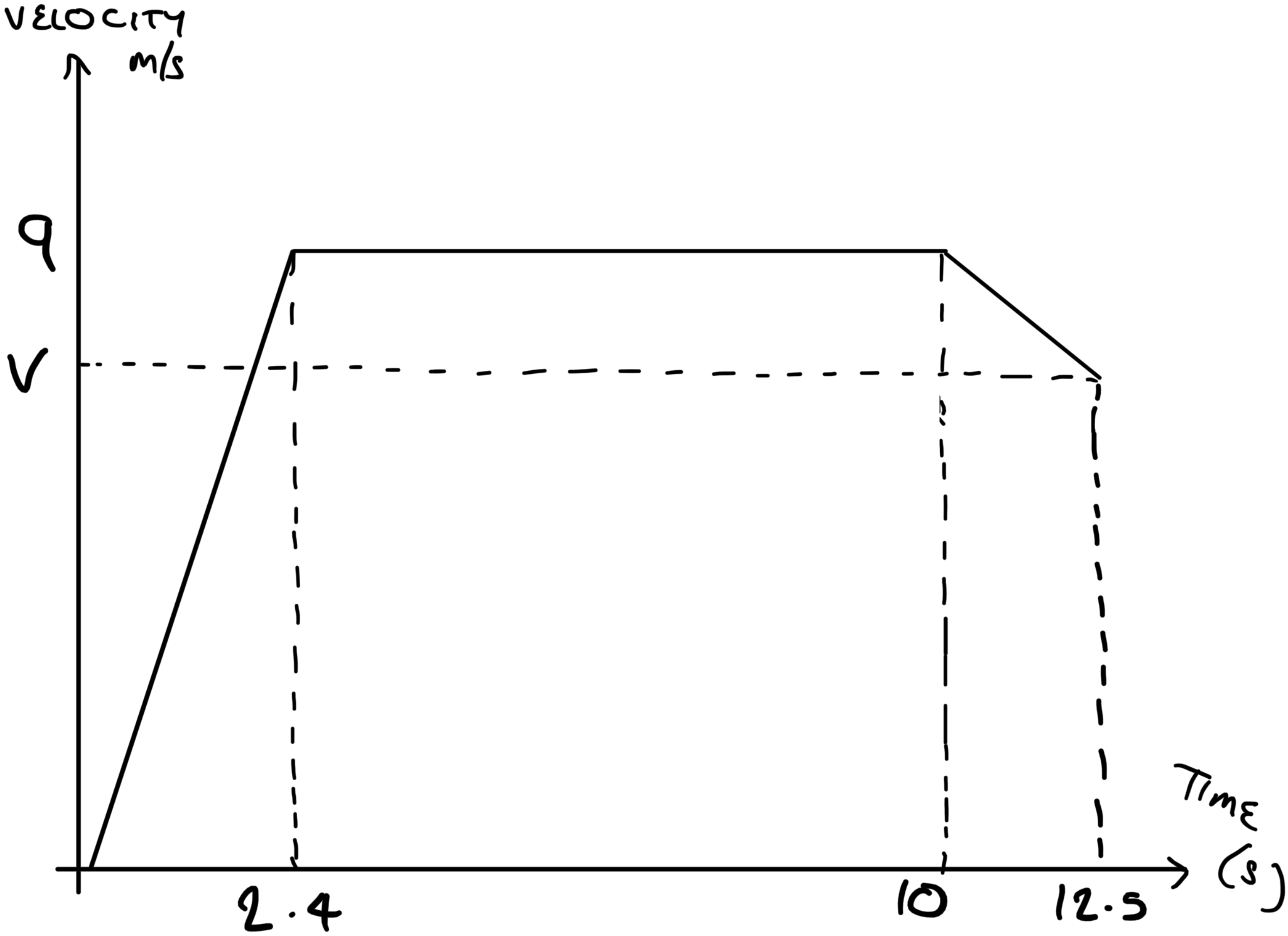
A sprinter running in a 100 m race took 12.5 seconds to complete the race.

He accelerated uniformly from rest to a maximum velocity of 9 m/s in 2.4 seconds.

He maintained this velocity for a further 7.6 seconds.

He then decelerated uniformly to a final velocity of V m/s in the final 2.5 seconds.

Draw a velocity–time graph of the sprinter's journey.



M1 CORRECT : SHAPE

M1 : LABELS

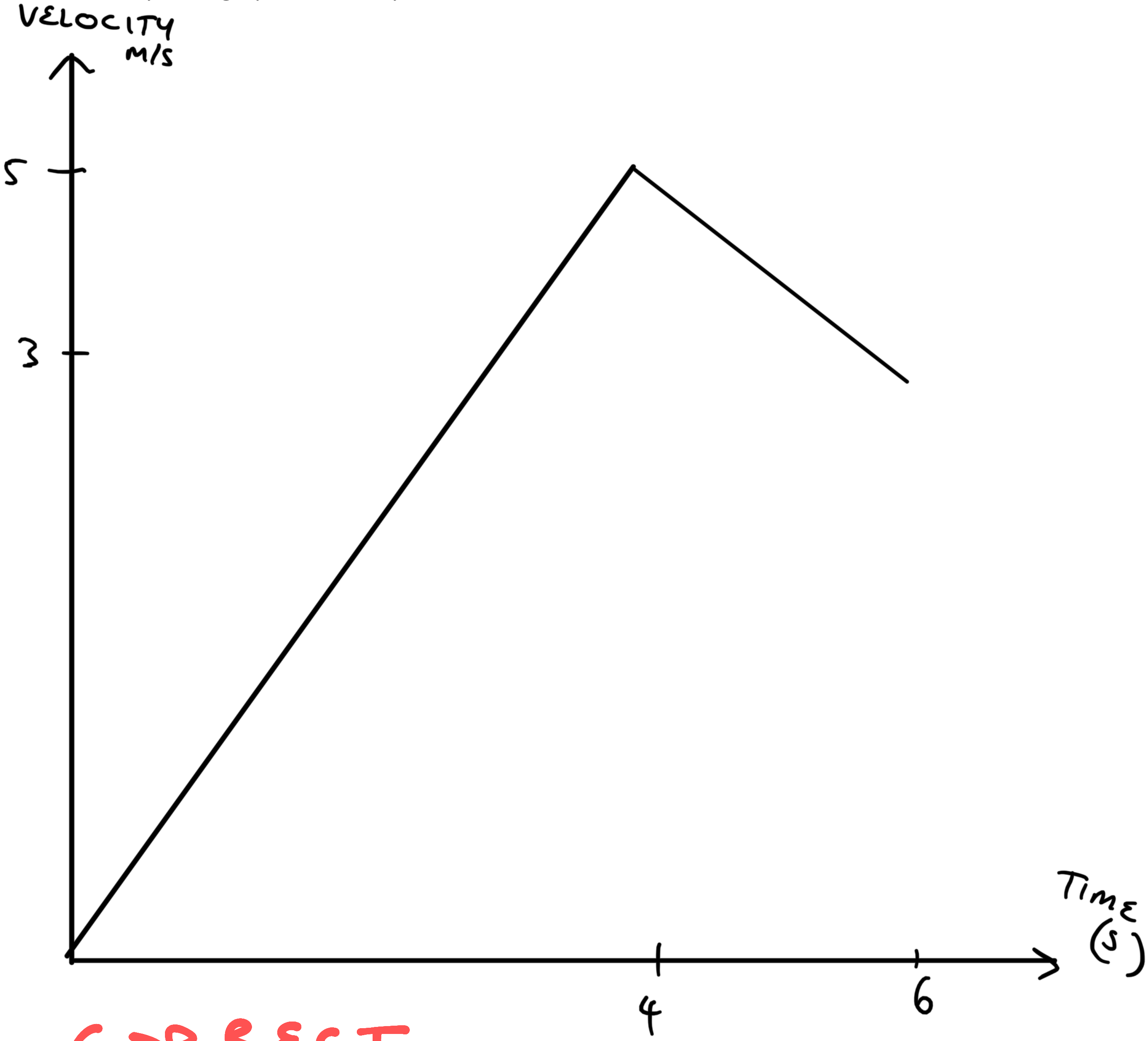
M1 : VALUES

(3 marks)

A toy car is placed on the floor of a sports hall.

It moves in a straight line starting from rest.
It travels with constant acceleration for 4 seconds reaching a velocity of 5 m/s. It then slows down with constant deceleration of 1 m/s ^{2} for 2 seconds.
It then hits a wall and stops.

Draw a velocity-time graph for the toy car.



CORRECT

M1 SHAPE

M1 LABELS

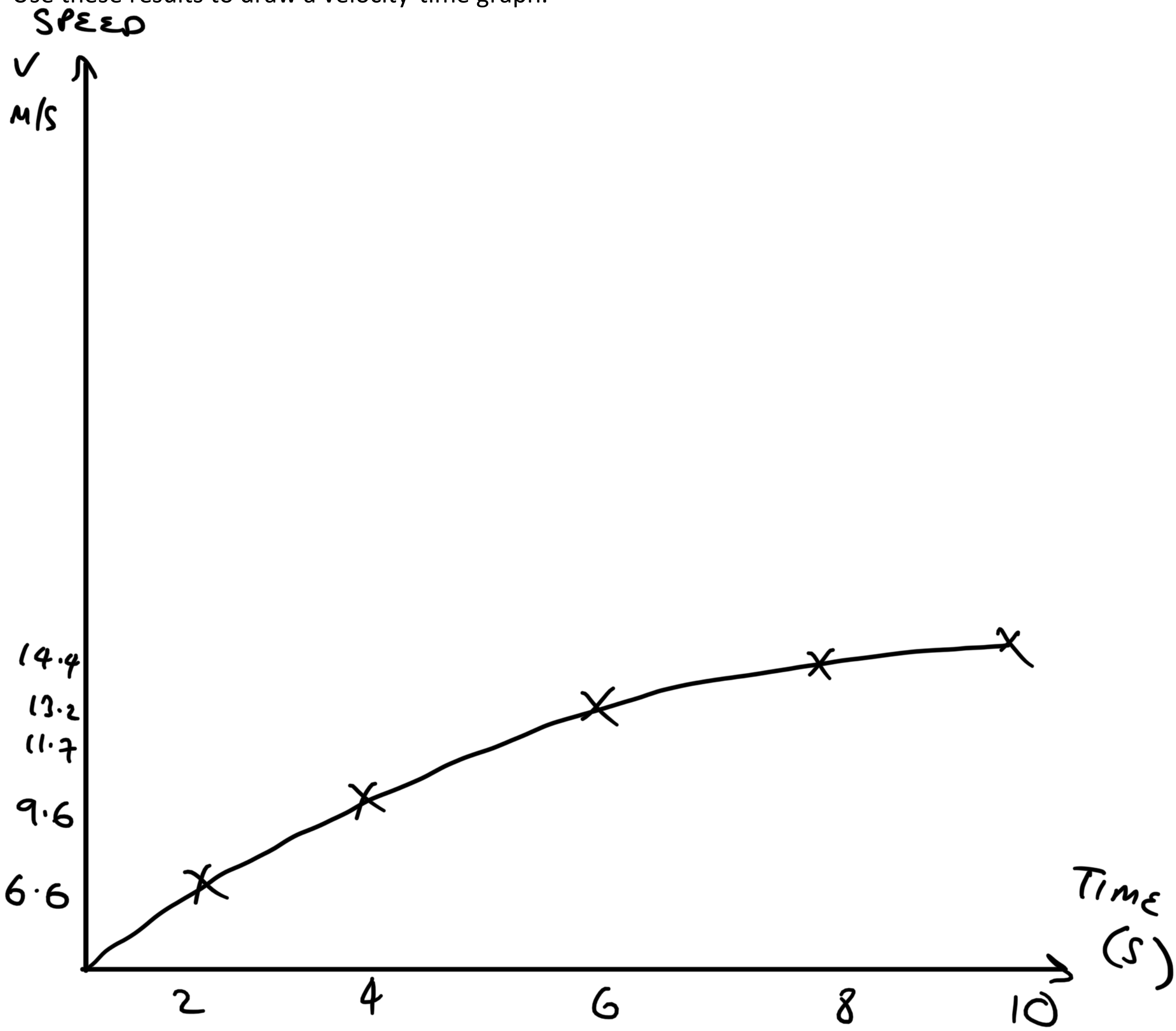
M1 VALUES

(3 marks)

Nina records the speed, in v ms $^{-1}$, at which she is travelling in her car t seconds after accelerating from rest. The results are shown in the table below.

Time (t seconds)	0	2	4	6	8	10
Speed V ms $^{-1}$	0	6.6	9.6	11.7	13.2	14.4

Use these results to draw a velocity-time graph.



B1 POINTS PLOTTED

B1 SMOOTH CURVE

B1 CORRECT LABELS AND VALUES

....

(3 marks)

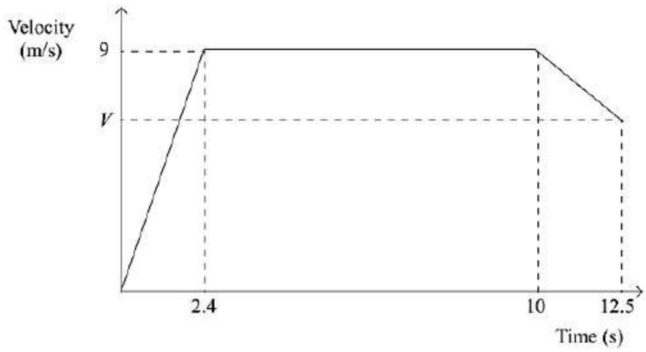
A sprinter running in a 100 m race took 12.5 seconds to complete the race.

He accelerated uniformly from rest to a maximum velocity of 9 m/s in 2.4 seconds.

He maintained this velocity for a further 7.6 seconds.

He then decelerated uniformly to a final velocity of V m/s in the final 2.5 seconds.

The velocity–time graph below shows the sprinter's journey.



(a) Calculate the distance travelled in the first 2.4 seconds.

$\frac{1}{2} \times 2.4 \times 9 =$

A1

10.8 m

(b) Calculate the distance travelled in the first 10 seconds.

M1

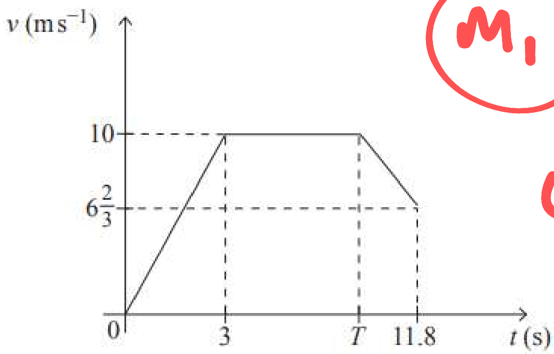
$\frac{1}{2} \times 2.4 \times 9 + 9 \times 7.6$

A1

$= 79.2$ m

(3 marks)

The diagram shows the velocity time graph for an athlete running a race.



M1 ATTEMPT TO FIND AREA UNDER CURVE

Given that T = 10, calculate the total length of the race.

$$100 = \left[\tfrac{1}{2} \times 3 \times 10\right] + (T-3)(10) + \tfrac{1}{2}\left(10 + 6\tfrac{2}{3}\right)(11.8 - T)$$ M1

$$100 = 15 + 10T - 30 + \tfrac{1}{2}(11.8 - T) \times \frac{50}{3}$$

$$115 = 10T - \frac{25}{3}T + \frac{295}{3}$$ M1

$$345 = 30T - 25T + 295$$

$$\therefore T = 10$$

A1

....

(4 marks)

Grace is driving her car along a straight horizontal road at 25m/s when she sees the following sign:

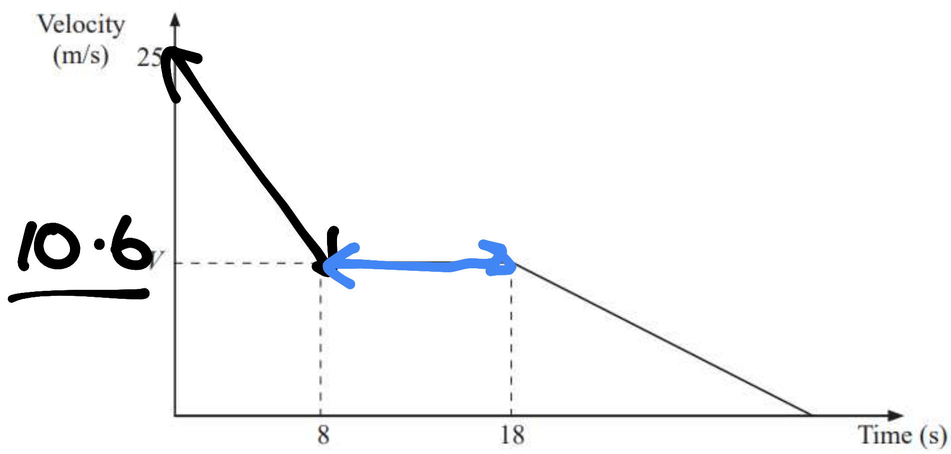
ROADWORKS **350 m** **AHEAD**

As she passes the sign, she applies the brakes and decelerates at 1.8m/s ^{2} for 8 seconds to reach a velocity of Vm/s.

Grace then travels at 10.6m/s for 10 seconds.

She brakes again so that her car decelerates uniformly to come to rest just as it reaches the roadworks.

This is illustrated in the velocity-time graph shown below.



Calculate the distance travelled by Grace in the first 18 seconds.

$\frac{1}{2}(25+10.6)(8) = 142.4$ M1

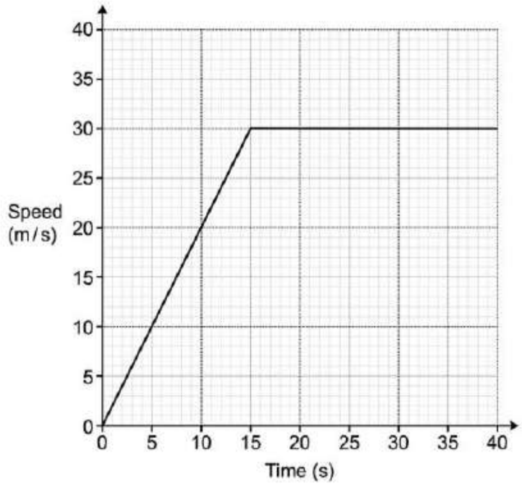
$10 \times 10.6 = 106\text{m}$ M1

$\underbrace{142.4 + 106}_{\text{M1}} = 248.4$ A1

……………………………………………

(4 marks)

The graph shows the speed of a vehicle during the first 40 seconds of motion.



Calculate the distance travelled by the vehicle during the 40 seconds.

$$\underbrace{\left(\frac{40+25}{2}\right)}_{M1} \times \underbrace{30}_{M1}$$

$$= 975\text{ m}$$

A1

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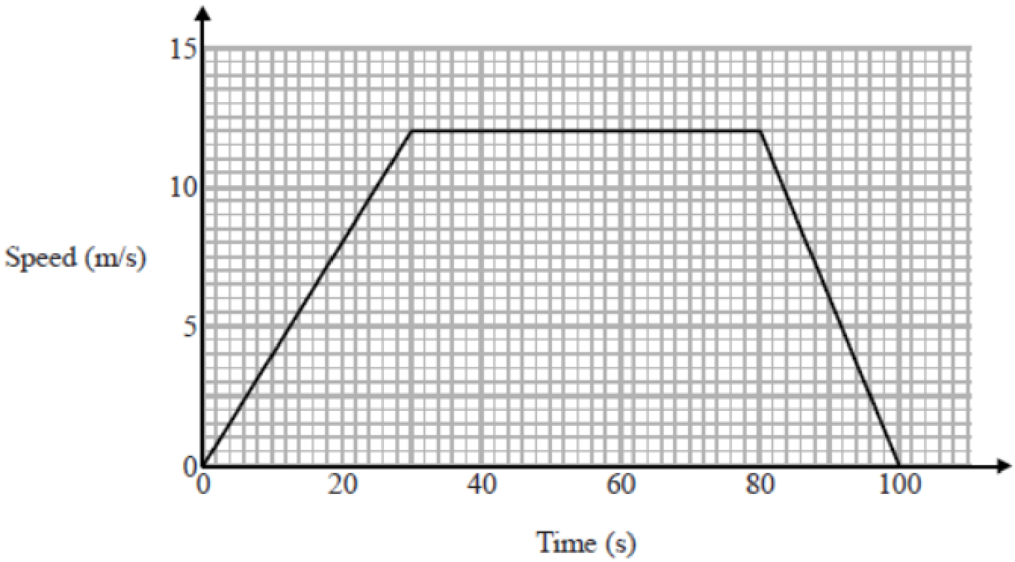
(3 marks)

Here is a speed-time graph for a train journey between two stations.
The journey took 100 seconds.



Calculate the time taken by the train to travel half the distance between the two stations.

$\frac{30 \times 12}{2} = 180$ P1

$50 \times 12 = 600$

$\frac{20 \times 12}{2} = 120$

$\therefore$ TOTAL $= 900$ P1

$\left(\frac{900}{2} - 180\right) \div 12 = 22.5$ P1

A1 52.5 s

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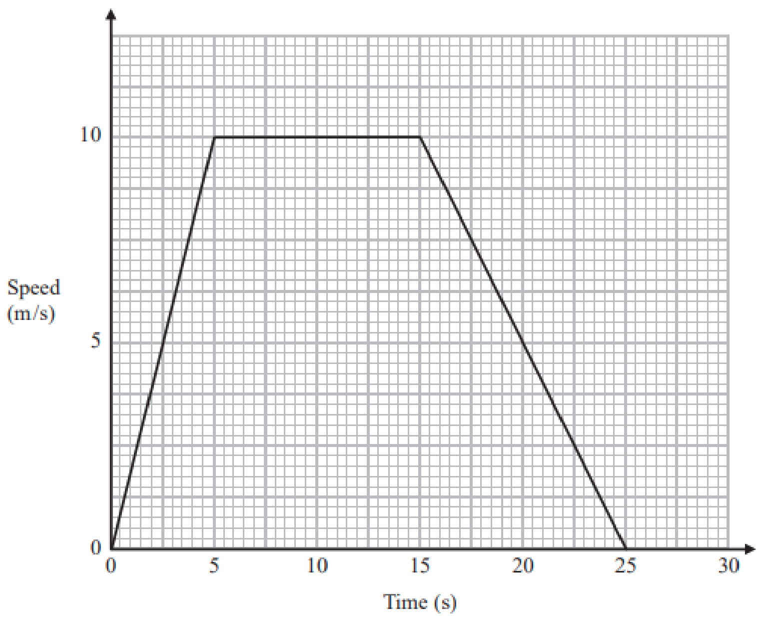
(4 marks)

A car travels along a straight road between two sets of traffic lights.
Here is the speed-time graph for this journey.



Find the total distance, in metres, that the car travels between the two sets of traffic lights.

$$\underbrace{\frac{10+25}{2} \times 10}_{M1} = 175\text{m}$$

A1

....

(2 marks)

Grace is driving her car along a straight horizontal road at 25m/s when she sees the following sign:

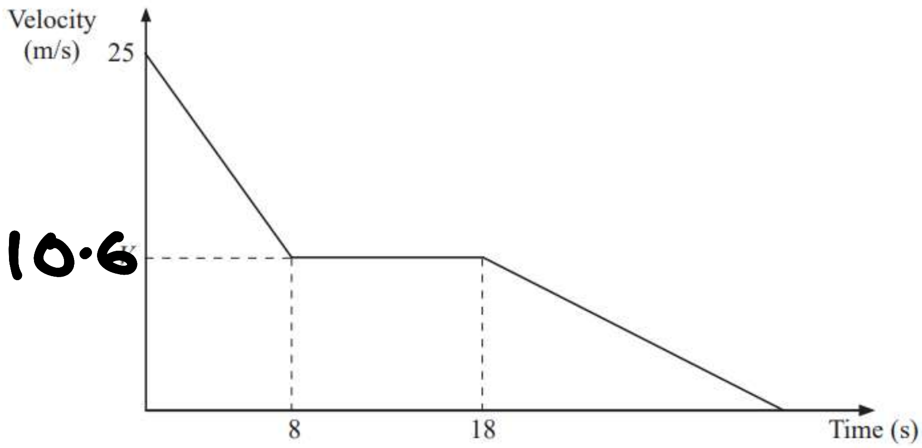
ROADWORKS
350 m
AHEAD

As she passes the sign, she applies the brakes and decelerates at 1.8m/s ^{2} for 8 seconds to reach a velocity of Vm/s.

Grace then travels at 10.6m/s for 10 seconds.

She brakes again so that her car decelerates uniformly to come to rest just as it reaches the roadworks.

This is illustrated in the velocity-time graph shown below.



Calculate the total time for the car to travel the 350 metres to reach the roadworks.

$350 - 248.4 = 101.6$ M1

$\frac{1}{2}(10.6)t = 101.6$ M1

$t = 19.17$ A1

TOTAL $= 18 + 19.17 = 37.17$ s A1

……………………………

(4 marks)

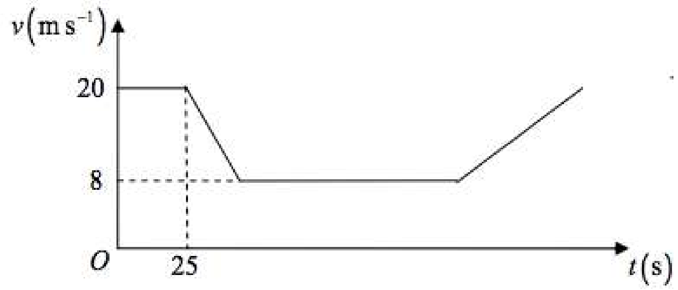
A car is moving on a straight horizontal road. At time $t = 0$, the car is moving with speed 20 m s^{-1} and is at the point A.

The car maintains the speed of 20 m s^{-1} for 25 s.

The car then moves with constant deceleration 0.4 m s^{-2}, reducing its speed from 20 m s^{-1} to 8 m s^{-1}.

The car then moves with constant speed 8 m s^{-1} for 60 s.

The car then moves with constant acceleration until it is moving with speed 20 m s^{-1} at the point B.



The time for which the car is decelerating is 30 seconds.

Given that the distance from A to B is 1960 m, find the time taken for the car to move from A to B.

M1

$1960 = (25 \times 20) + (30 \times 8) + (\frac{1}{2} \times 30 \times 12) + (60 \times 8) + (8 \times t) + (\frac{1}{2} \times t \times 12)$

$1960 = 500 + 240 + 180 + 480 + 8t + 6t$

M1

A1

$T =$ 155

(4 marks)

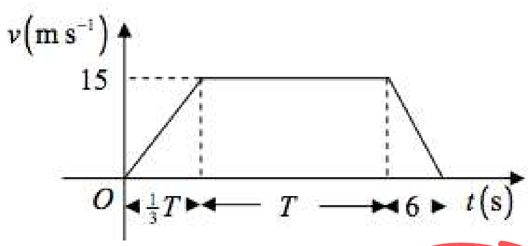
A car moves along a straight horizontal road from a point *A* to a point *B*, where *AB* = 885 m.

The car accelerates from rest at *A* to a speed of 15 m s^{-1} at a constant rate *a* m s^{-2}.

The time for which the car accelerates is $\frac{1}{3}T$ seconds. The car maintains the speed of 15 m s^{-1} for *T* seconds.

The car then decelerates at a constant rate of 2.5 m s^{-2} stopping at *B*.

A sketch of a speed-time graph for the motion of the car is shown below.



Find the value of *T*.

M1 A1

$$\frac{1}{2} \times 15 \times \left(\frac{4}{3}T + 6 + T\right) = 885$$

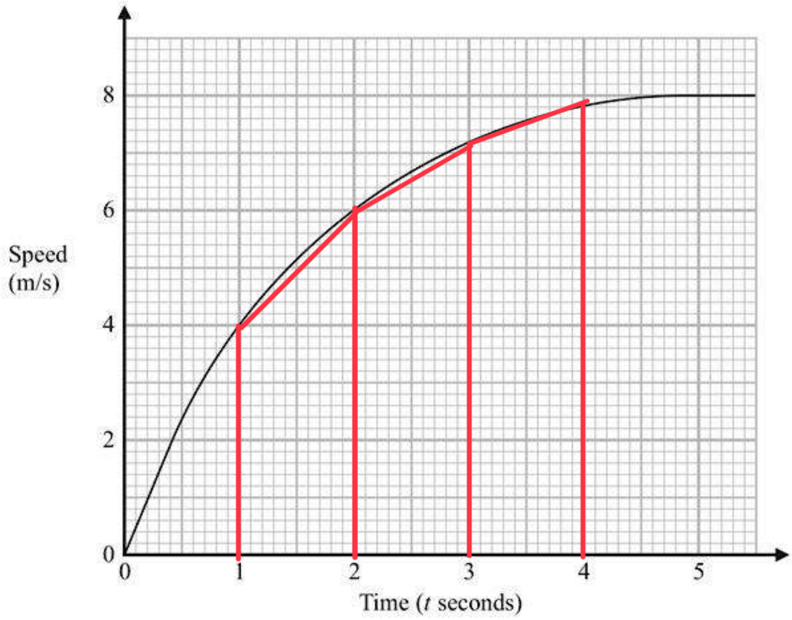
$$\frac{7}{3}T = 118 - 6 \quad \text{M1}$$

$$T = 112 \times \frac{3}{7} = 48 \quad \text{A1}$$

T = ...

(4 marks)

Here is a speed-time graph showing the speed, in metres per second, of an object t seconds after it started to move from rest.



Using 3 trapeziums of equal width, work out an estimate for the area under the graph between $t = 1$ and $t = 4$

$\frac{4+6}{2} \times 1 = 5$ M1

$\frac{6+7}{2} \times 1 = 6.5$

$\frac{7+8}{2} \times 1 = 7.5$

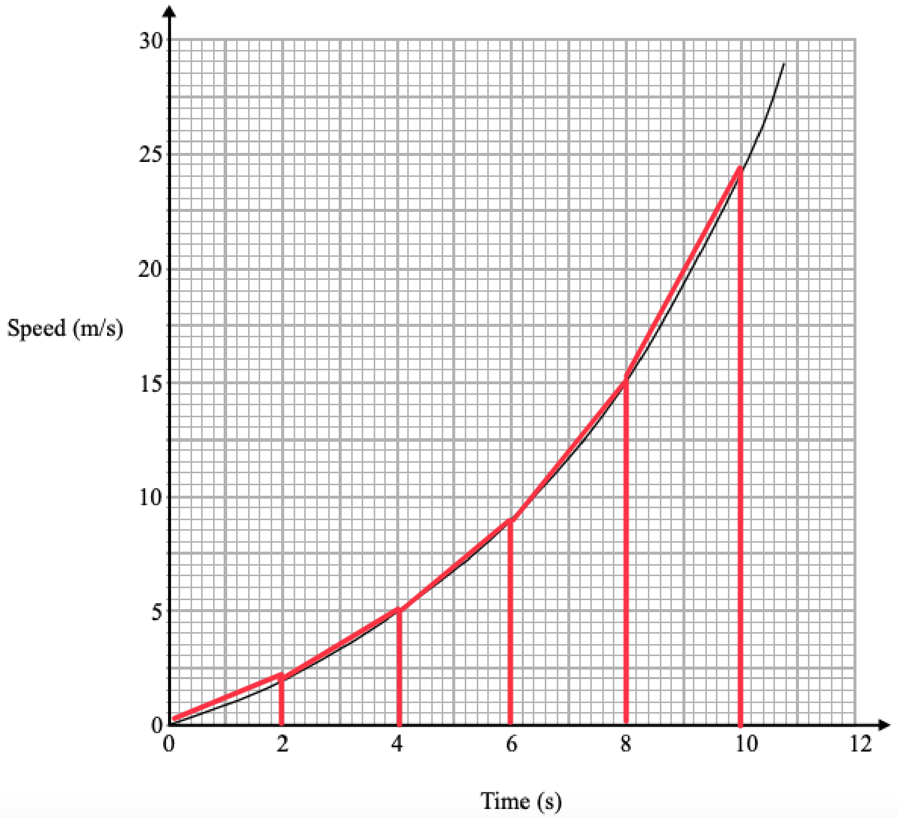
M1

$\underline{\underline{19}}$ A1

....

(3 marks)

Here is the speed-time graph for a car.



By using 5 strips of equal width, work out an estimate for the distance the car travelled in the first 10 seconds.

$\frac{2+5}{2} \times 2 = 7$ $\frac{5+9}{2} \times 2 = 14$

$\frac{9+15}{2} \times 2 = 24$ $\frac{15+24}{2} \times 2 = 39$

$\frac{0+2}{2} \times 2 = 2$

M1 A COMPLETE METHOD

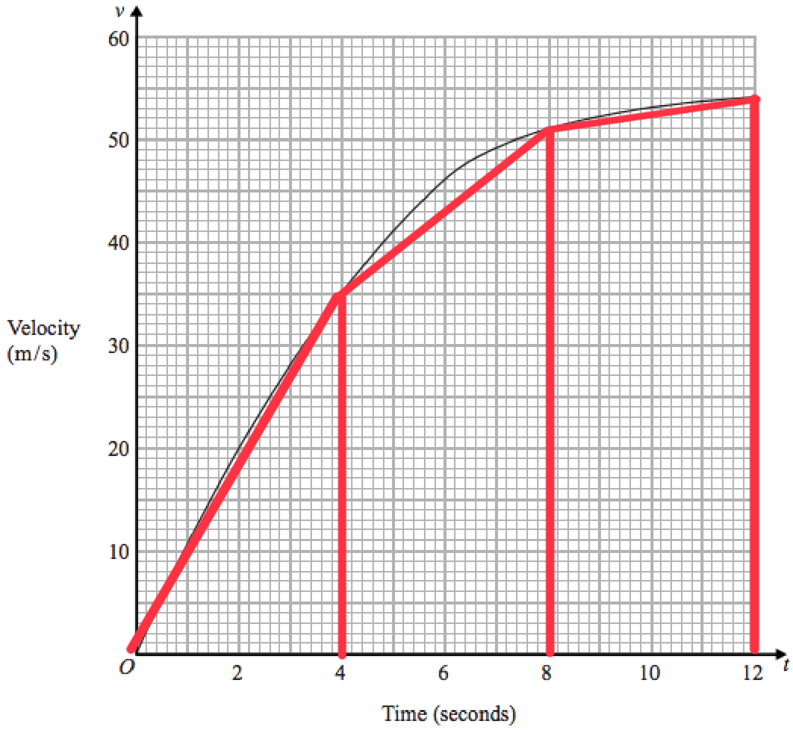
M1 ONE STRIP

A1

86

(3 marks)

The graph shows information about the velocity, v m/s, of a parachutist t seconds after leaving a plane.



Work out an estimate for the distance fallen by the parachutist in the first 12 seconds after leaving the plane. Use 3 strips of equal width.

$$\frac{0+35}{2} \times 4 = 70$$

$$\frac{35+50}{2} \times 4 = 170$$

$$\frac{50+54}{2} \times 4 = 208 +$$

$$448$$

M1 ONE CORRECT STRIP

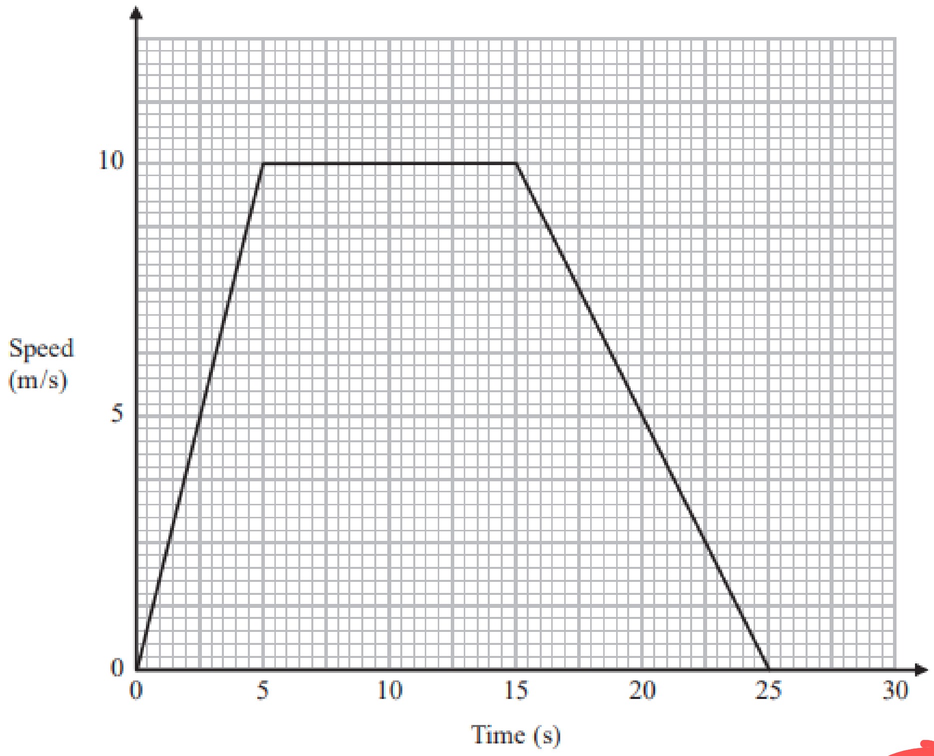
M1 COMPLETE METHOD

A1

....

(3 marks)

A car travels along a straight road between two sets of traffic lights.
Here is the speed-time graph for this journey.



Work out the acceleration of the car during the first 5 seconds.

$$\frac{\Delta y}{\Delta x} = \frac{10}{5} = 2\ ms^{-2}$$

A1

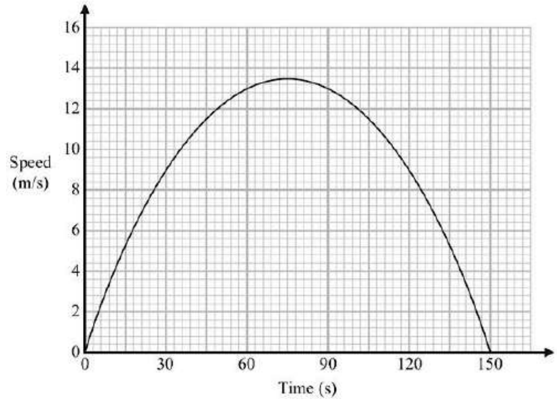
M1

....

(2 marks)

Q17.

Here is a speed-time graph for a car.



The distance the car travelled in the first 30 seconds has been estimated to be 135 m.

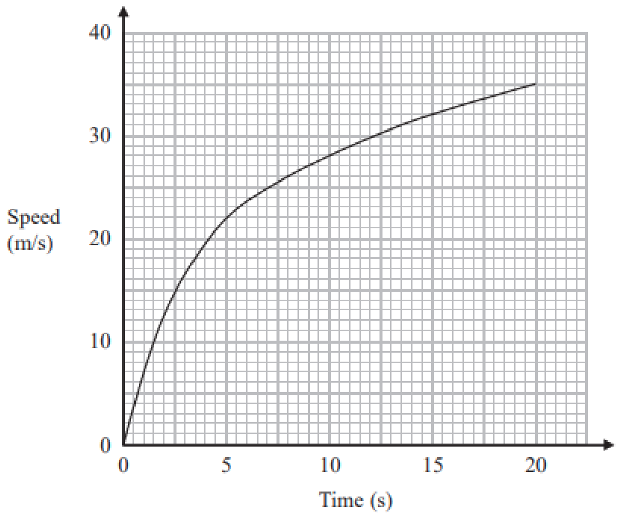
Is this an underestimate or an overestimate of the actual distance the car travelled in the first 30 seconds?

UNDERESTIMATE ....

(1 mark)

Q18.

The graph shows the speed of a car, in metres per second, during the first 20 seconds of a journey.



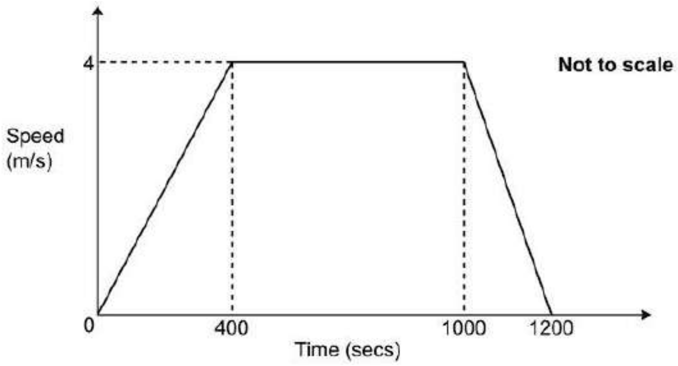
An estimate for the distance the car travelled in the first 20 seconds can be calculated using 4 strips of equal width. Would it be an underestimate or an overestimate?

UNDERESTIMATE ....

(1 mark)

Q19. AtoZrevision.com

An athlete goes for a training run.
The graph shows their speed as they run.



Write down the athlete's acceleration between 400 seconds and 1000 seconds.

(NO ACCELERATION) 0

(1 mark)

Q20. AtoZrevision.com

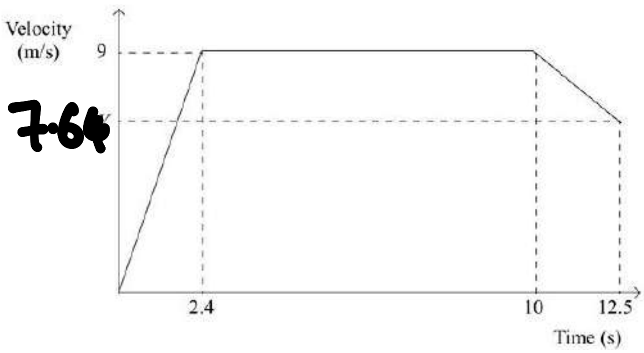
A sprinter running in a 100 m race took 12.5 seconds to complete the race.

He accelerated uniformly from rest to a maximum velocity of 9 m/s in 2.4 seconds.

He maintained this velocity for a further 7.6 seconds.

He then decelerated uniformly to a final velocity of V m/s in the final 2.5 seconds.

The velocity–time graph below shows the sprinter's journey.



The value of V has been calculated to be 7.64.

Calculate the sprinter's **deceleration** for the last part of the race.

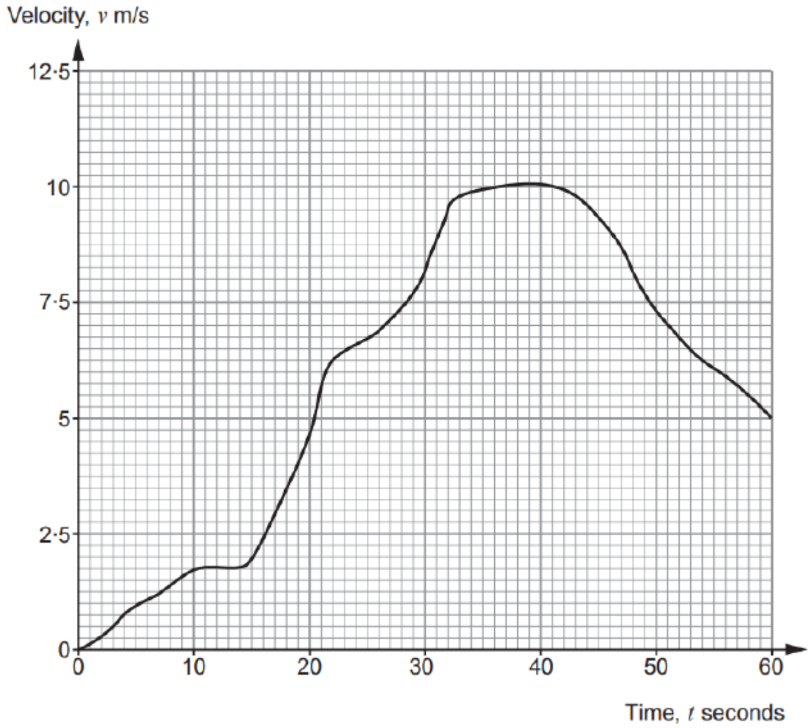
M1

$$\frac{\Delta y}{\Delta x} = \frac{1.36}{2.5} = 0.544\ \text{ms}^{-2}$$

A1

(2 marks)

The velocity-time graph below shows the first 60 seconds of a car's journey.



Harriet argues that the acceleration at t = 22 represents the typical acceleration of the car during the first 32 seconds of this period.

S1

State whether Harriet is correct or not. Give a reason to justify your answer.

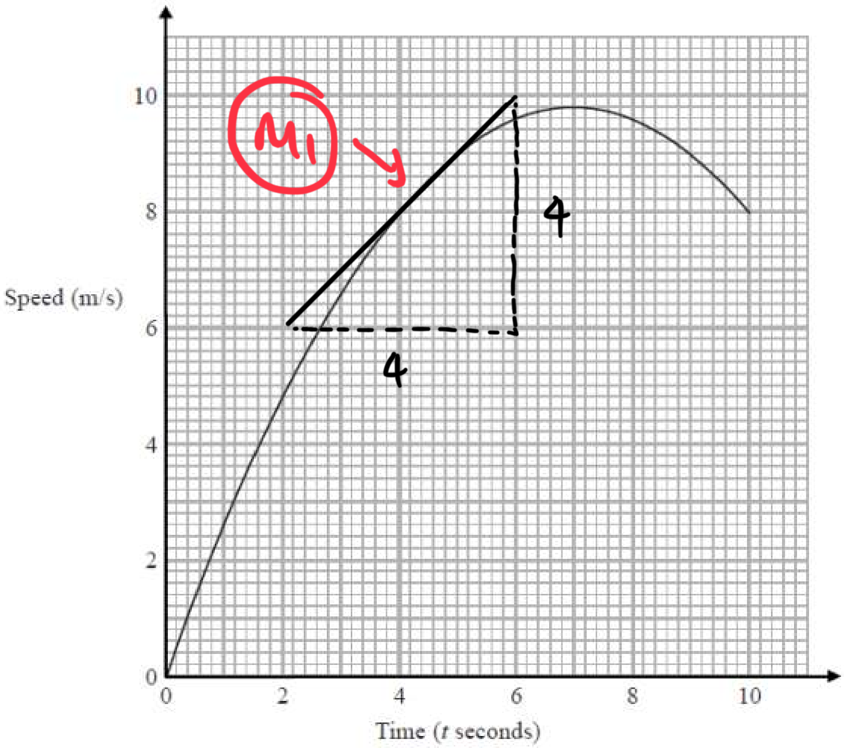
B1

CORRECT. TANGENT AT T=22 IS ALMOST PARALLEL TO GRADIENT DURING FIRST 32 SECONDS.

(2 marks)

Karol runs in a race.

The graph shows her speed, in metres per second, t seconds after the start of the race.



Calculate an estimate for the gradient of the graph when $t = 4$
You must show how you get your answer.

$$\frac{4}{4} = \frac{\Delta y}{\Delta x} = 1$$

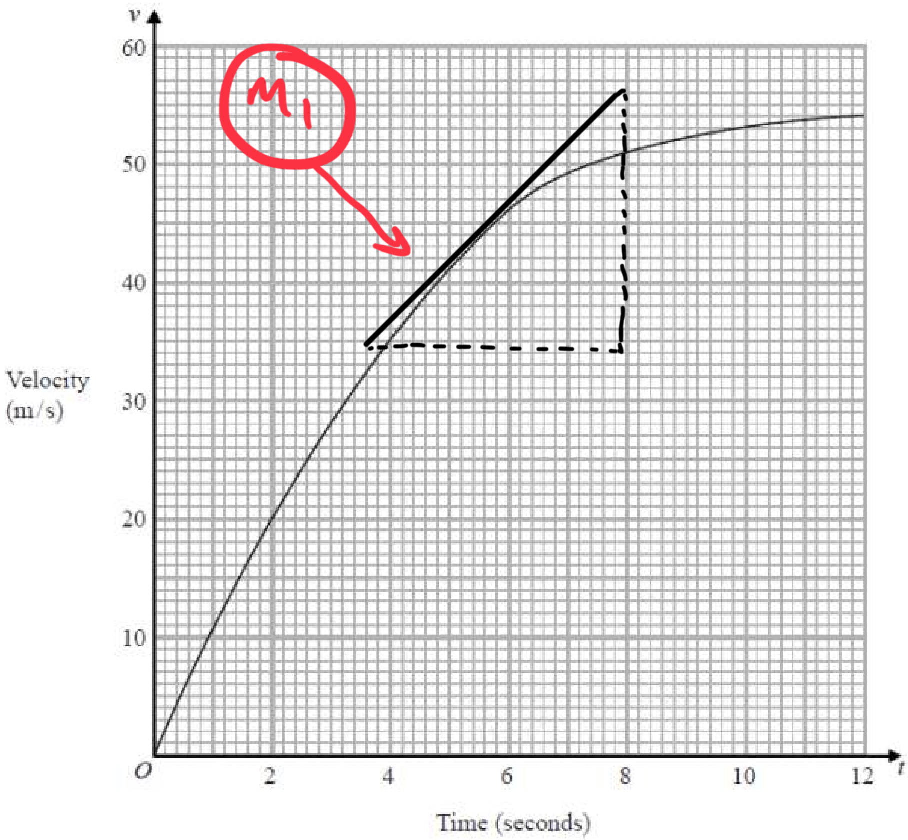
M1

A1

1 ....

(3 marks)

The graph shows information about the velocity, v m/s, of a parachutist t seconds after leaving a plane.



Work out an estimate for the acceleration of the parachutist at $t = 6$

$$\frac{22}{4.4} = \frac{\Delta y}{\Delta x} = 5$$

M1

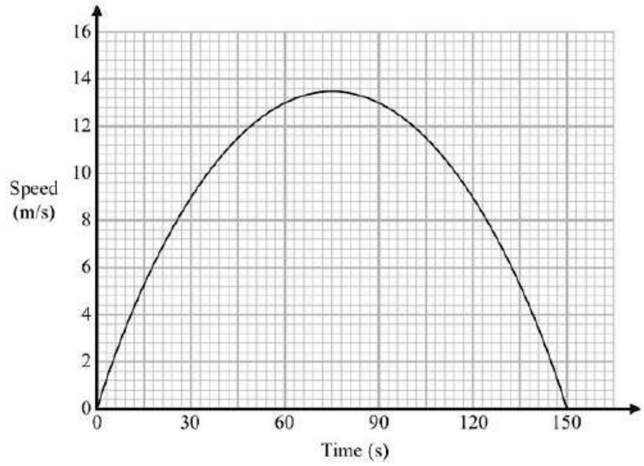
A1

5

....

(3 marks)

Here is a speed-time graph for a car.



Julian used the graph to answer this question.

Work out an estimate for the acceleration of the car at time 60 seconds.

Here is Julian's working.

$$\text{acceleration} = \text{speed} \div \text{time}$$

= 13 / 60

= 0.21666666

Julian's method does not give a good estimate of the acceleration at time 60 seconds.
Explain why.

HE HASN'T DRAWN A TANGENT AT T=60 AND HASN'T WORKED OUT THE GRADIENT.

(1 mark)