Speed, Distance and acceleration

Foundation Tier

Equations

current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
% efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$	
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Multiplier
m	1×10^{-3}
k	1×10^{3}
M	1×10^{6}

1. Road traffic accidents occur when a vehicle is unable to stop safely. The overall stopping distance can be worked out using the following equation:

overall stopping distance = thinking distance + braking distance

The table shows stopping distances from the Highway Code.

Speed (mph)	20	30	40	50	60	70
Thinking distance (m)	6	9	12	15	....	21
Braking distance (m)	6	14	24	38	56	75
Overall stopping distance (m)	12	23	36	53	....	96

(a) **Complete the table.** [2]

(b) (i) Describe how worn tyres affect the following distances. [2]

Thinking distance ....

Braking distance ....

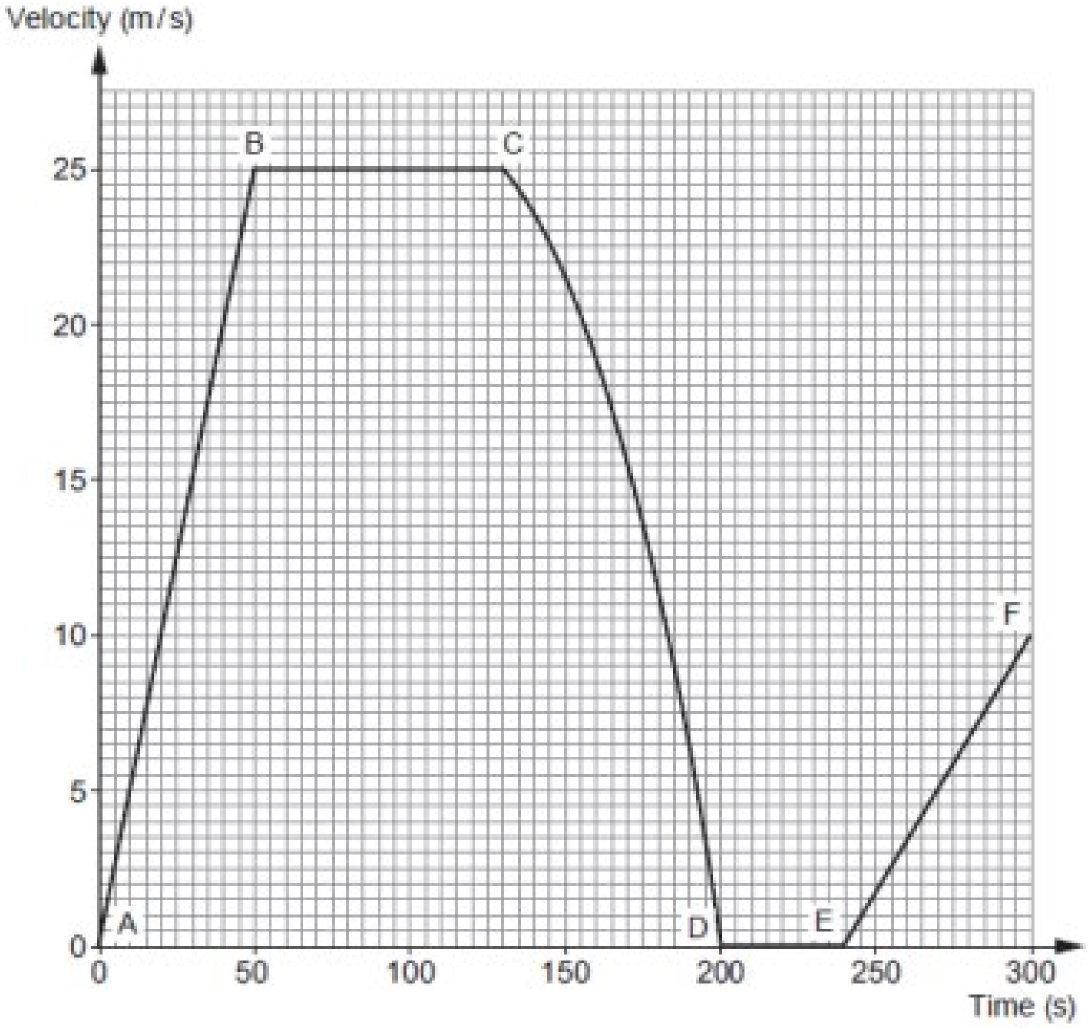
(ii) Describe how a driver using a mobile phone affects the following distances. [2]

Thinking distance ....

Braking distance ....

Separate Physics 2018 Q7

The velocity-time graph below shows part of the motion of an empty school bus.



(a) Use values from the graph to describe the motion of the bus over the time shown. [Note that no calculations are required as part of your answer.] [6 QER]

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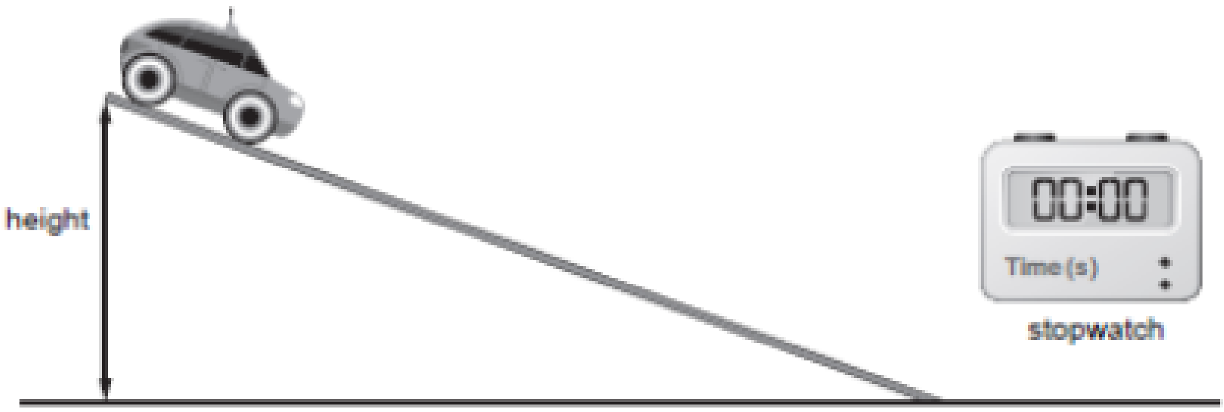
Two students carry out an experiment with a toy car and a 2.50 m long piece of track.



They investigate how changing the height at one end of the track affects the time taken for the toy car to travel down 2.50 m of the track. One student releases the car and the other uses a stopwatch to measure the time. They do this 3 times for each height.
Their results are shown in the table.

Height (cm)	Distance travelled (m)	Time (s)			
		Result 1	Result 2	Result 3	Mean
10	2.50	4.0	4.1	4.0	4.0
20	2.50	2.9	3.3	3.1	3.1
30	2.50	2.5	2.7	2.4	2.5
40	2.50	2.1	2.0	2.3	2.1
50	2.50	2.0	1.8	1.9	1.9

(a) Identify a controlled variable in the table. [1]

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(b) (i) Use the equation:

$$\text{mean speed} = \frac{\text{distance travelled}}{\text{mean time}}$$

to calculate the mean speed of the toy car when the slope is set at a height of 10 cm. [2]

Mean speed = ... m/s

(ii) I. Describe how the mean time changes as the height increases by 10 cm steps. [2]

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II. Describe how the mean speed changes as the height increases. [1]

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(c) (i) One student says, "The most repeatable data is for a height of 50 cm". Explain why this statement is **incorrect** and write a similar correct statement. [2]

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(ii) Explain why using a timer connected to light gates positioned at the start and end of the 2.50 m track will improve the results. [2]

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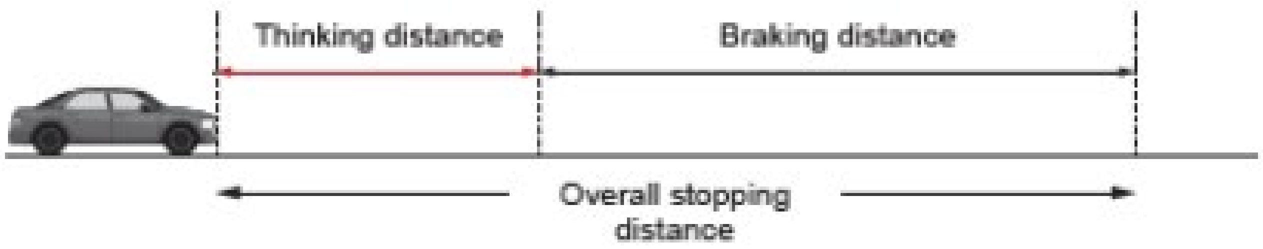
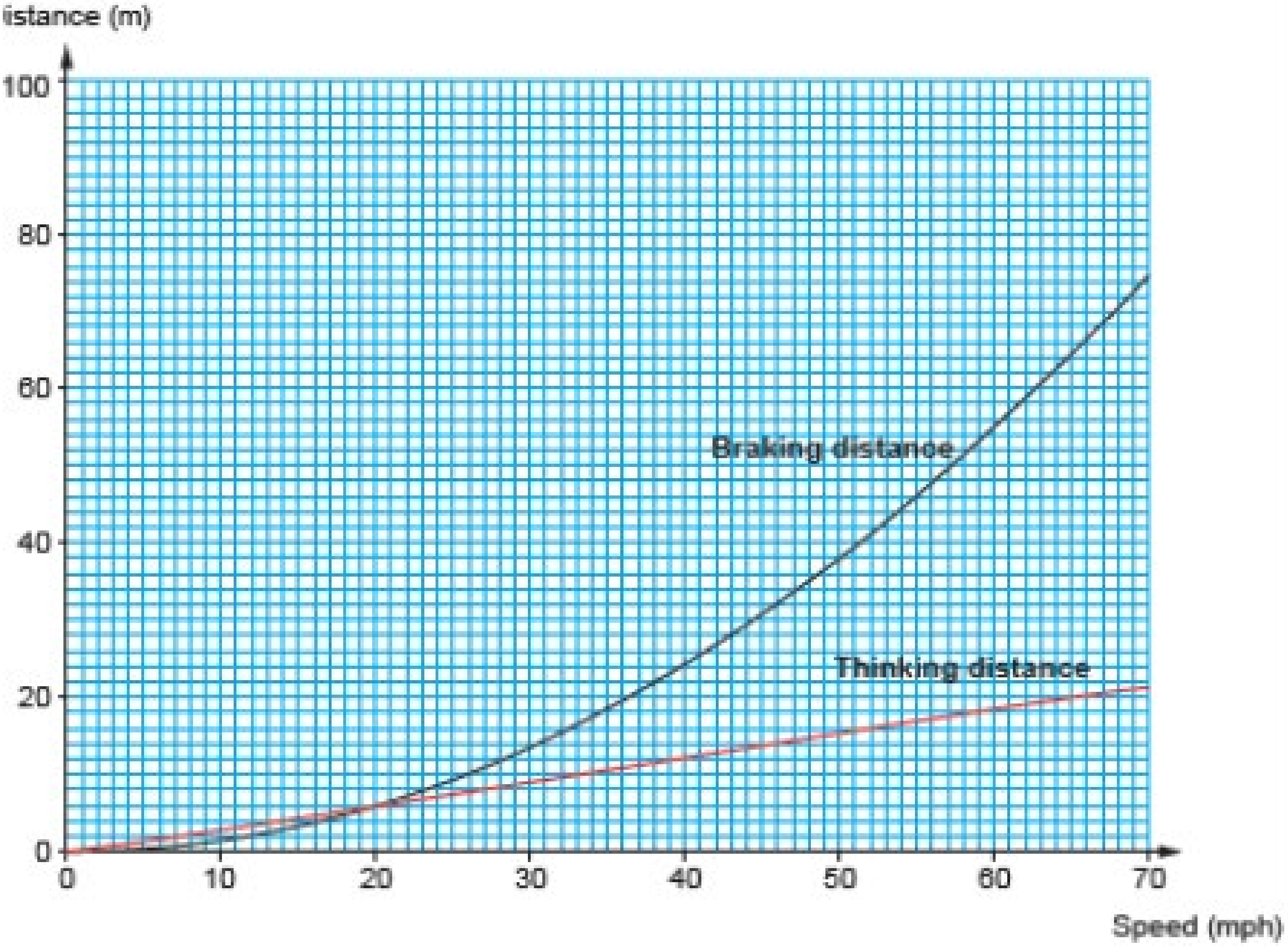
Separate Physics 2019 Q9

The overall stopping distance of a car is made up of two parts:

- the distance that the car travels when the driver is reacting (thinking distance)
- the distance that the car travels after the brakes have been applied (braking distance).



The graph below shows how the thinking distance and braking distance depend on the speed of a vehicle under good conditions.



The table below shows the conversion from mph into m/s.

Speed (mph)	20	40	60	70
Speed (m/s)	9	18	27	31

(a) (i) It is suggested that both thinking distance and braking distance are directly proportional to speed. Explain whether this suggestion is true. [2]

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(ii) Use information on page 16 and the equation:

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

to calculate the **thinking** time of the driver when travelling at 40 mph. [3]

Thinking time = ... s

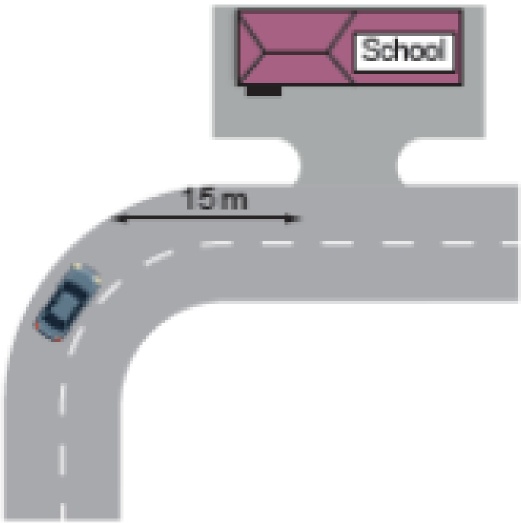
(iii) Use the information on the graph to complete the table below. [2]

Speed (mph)	0	20	30	40	60	70
Overall stopping distance (m)	....	....	....	....	....	....

(iv) Use the data in the table to **plot** the points on the grid opposite **and draw a line** to show how the overall stopping distance depends on speed. [3]

(b) The speed limit along a road outside a school in Cardiff was 30 mph. The council decided to reduce this to 20 mph in 2017.

The entrance to the school is situated 15 m after a bend in the road.



Explain how the change in speed limit affects the chance of children getting knocked down as they cross the road outside the school entrance. Use data to support your answer. [3]

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The total stopping distance for a moving car is given by the equation below:

total stopping distance = thinking distance + braking distance

(a) These distances may be affected by a number of factors.
Three of these factors are given in the table below.

Put a **tick** (✓) or a **cross** (**X**) in each box below to show whether the distance is affected by each factor. [3]

The first row has been done for you.

Factor	Thinking distance	Braking distance	Total stopping distance
Worn tyres	**X**	✓	✓
Drunk driver			
Wet road			

(b) At a speed of 13 m/s, the thinking distance of an alert driver is 9.1 m.

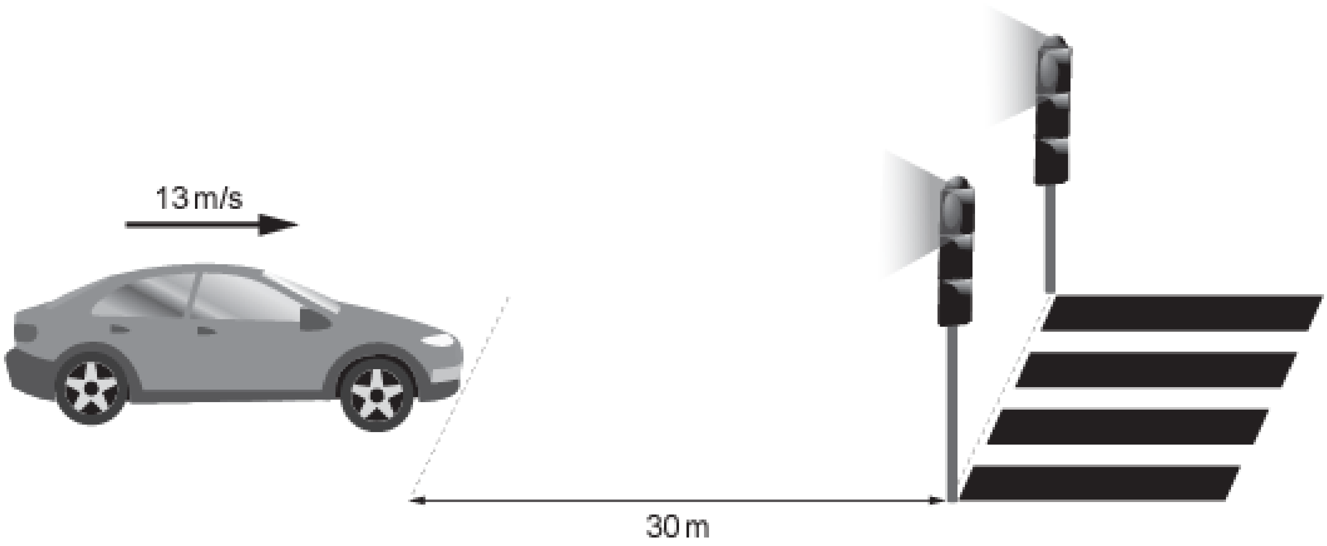
Use the equation:

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

to calculate the thinking time. [2]

Thinking time = ... s

(c) A driver of a car travelling at 13 m/s sees traffic lights 30 m ahead when the lights turn to red.



The thinking distance = 9.1 m and the braking distance = 13.9 m at this speed.

Use the equation:

total stopping distance = thinking distance + braking distance

to explain whether the car would be able to stop before reaching the crossing. [2]

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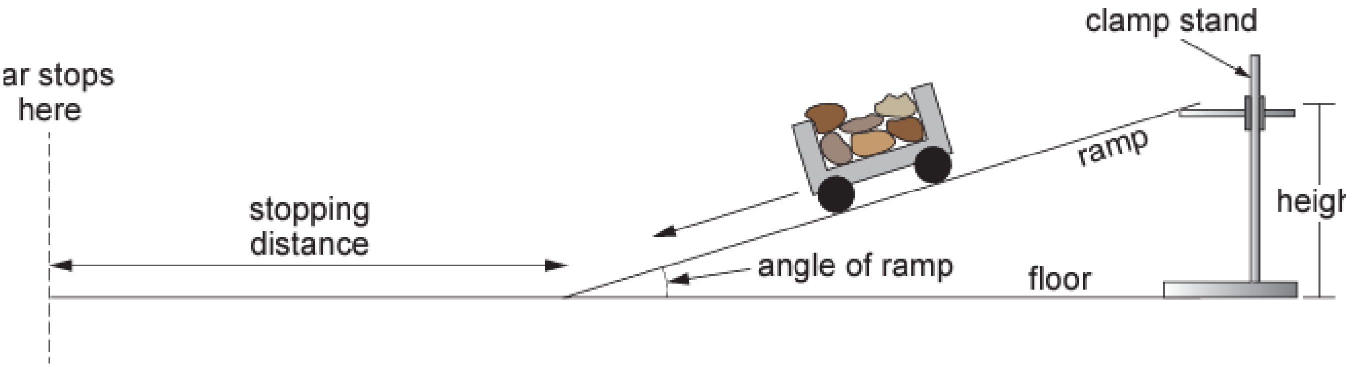
In a class experiment, some students investigate the stopping distance of a toy car after it travels down a ramp.
In their experiment, they add stones to the toy to investigate whether its total weight affects its stopping distance along the flat floor.



(a) State the **dependent** variable. [1]

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(b) The students are asked to investigate other variables that would affect its stopping distance.
Using the same apparatus given, state **two** other independent variables they could investigate. [2]

1. ....

2. ....

(a) In dry conditions, a Formula One (F1) car can accelerate from 0 to 30 m/s in 1.5 seconds in a straight line.

(i) State the change in velocity. [1]

Change in velocity = ... m/s

(ii) Use the equation:

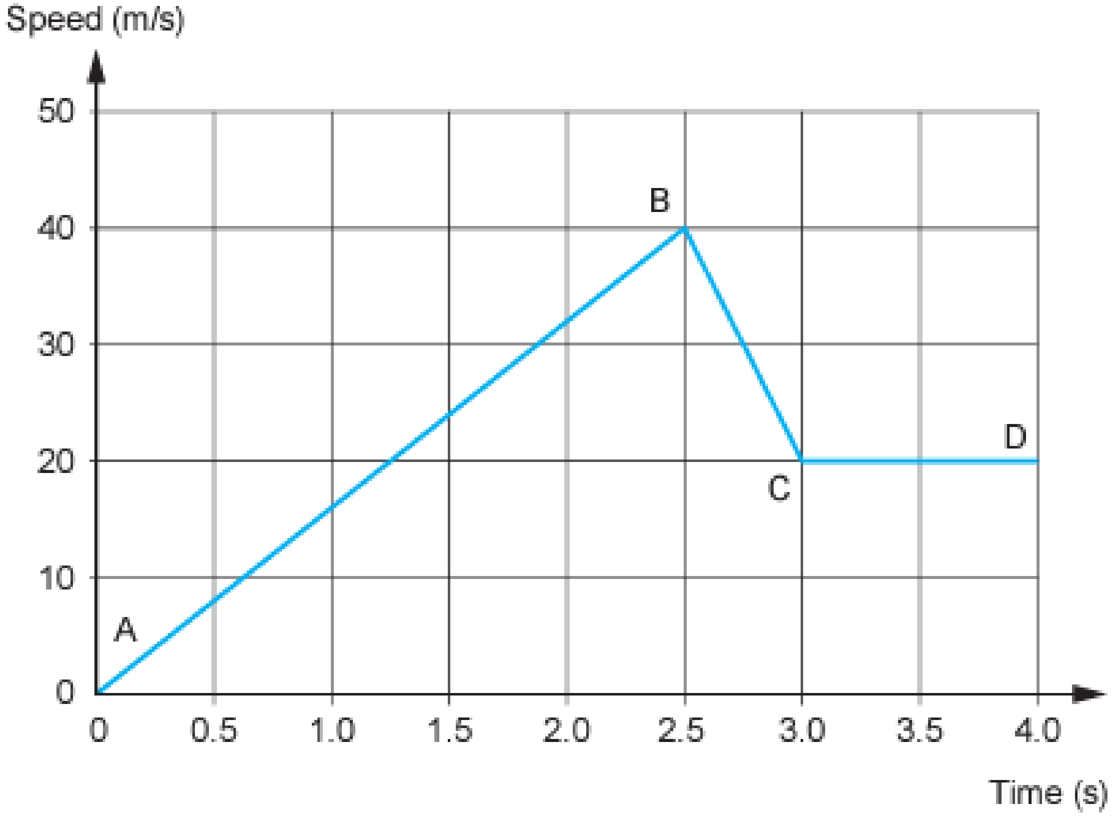
$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

to calculate the acceleration of the racing car. [2]

Acceleration = ... m/s^2

(b) The photograph shows F1 cars lined up on the grid.

The graph below shows how the speed of a F1 racing car changes at the start of a race as it leaves the grid and goes around the first bend.



(i) **Use data from the graph** to describe the motion of the car during the time shown. No calculations are required. [6 QER]

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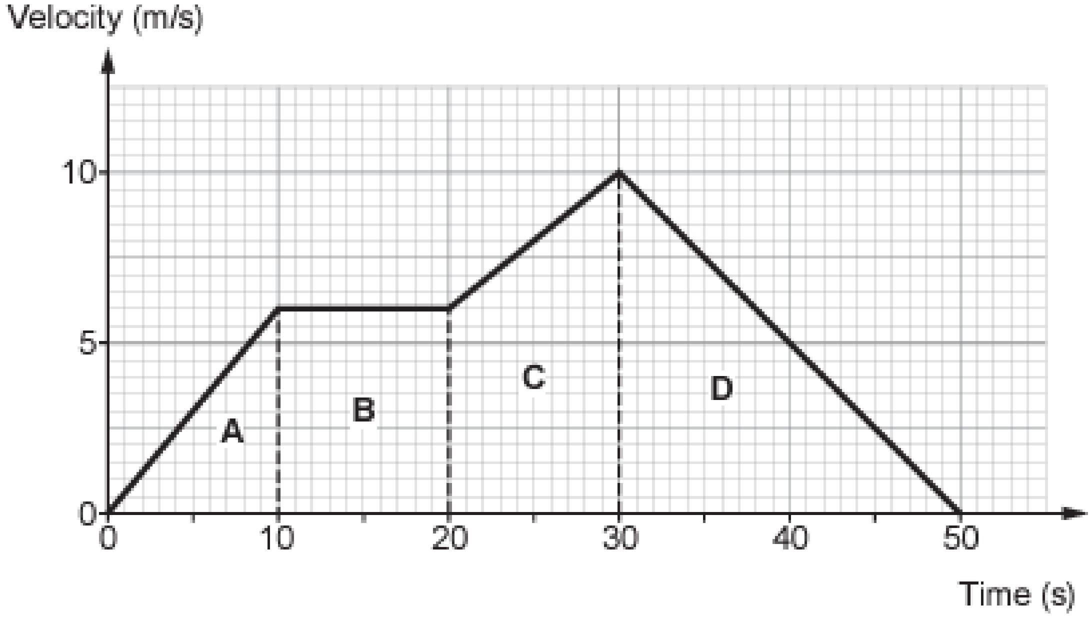
(ii) The car travels 85 m during the time shown by the graph.
Use an equation from page 2 to calculate the mean speed of the car during this time. [3]

Mean speed = ... m/s

The velocity-time graph is for part of a bus journey.



Use the information in the graph to answer the following questions.

(a) **Complete the table** by placing **one** tick (✓) in each row to describe the motion in each region of the graph. Region A has been completed as an example. [3]

Region of graph	Not moving	Constant velocity	Accelerating	Decelerating
A			✓	
B				
C				
D				

(b) **Complete the following sentences** using numbers from the box. [3]

2	4	6	8	10	20	50

(i) The maximum velocity of the bus is .... m/s.

(ii) The change in velocity of the bus in region C is .... m/s.

(iii) The bus accelerates for a **total time** of .... s.

(c) Use the equation:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

to calculate the acceleration in **region A**. [3]

acceleration = ... m/s^2

(d) The bus travelled 270 m in the 50 s shown.

Use the equation:

$$\text{mean speed} = \frac{\text{distance}}{\text{time}}$$

to calculate the mean speed of the bus. [2]

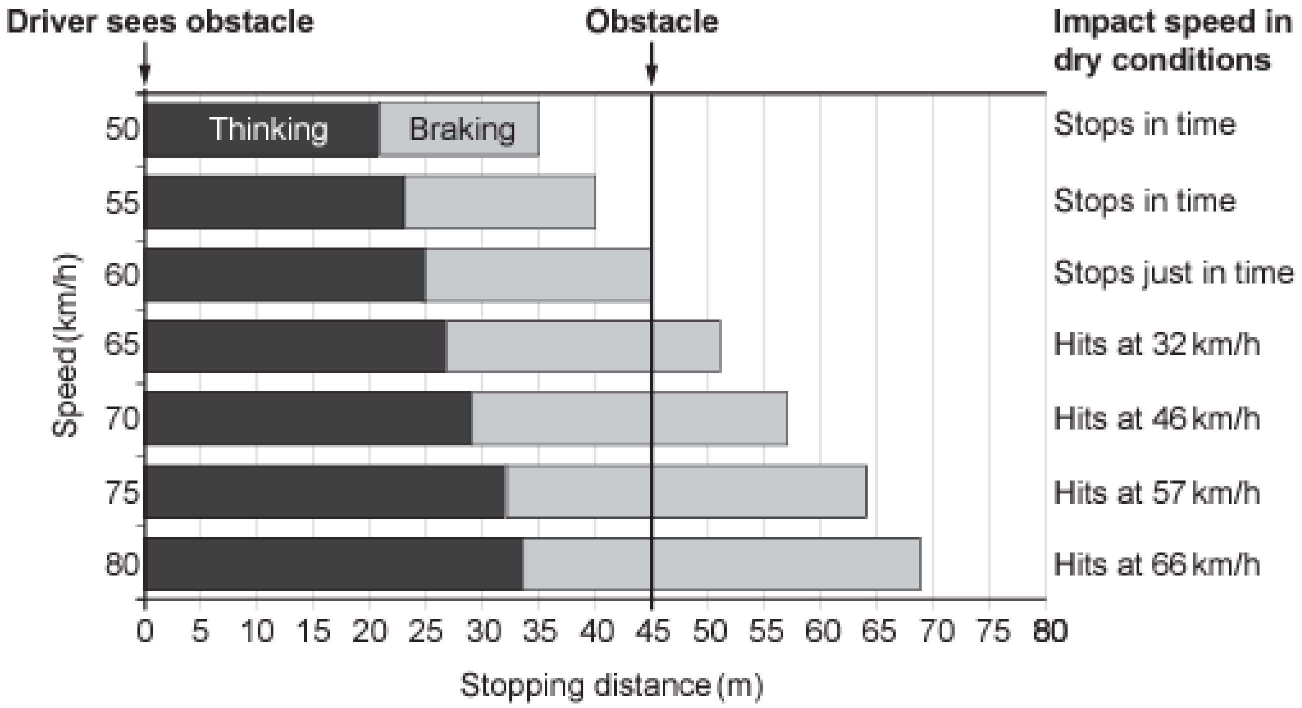
mean speed = ... m/s

The chart below is used by traffic collision investigators. It gives the thinking, braking and stopping distances of cars driven at different speeds by an alert driver on a dry road.

Stopping distance is given by the following equation:

stopping distance = thinking distance + braking distance

An alert driver notices an obstacle 45 m away on the road ahead. The position of this obstacle is represented by the dark vertical line. If there is a collision, the chart also shows the impact speed with the obstacle.



(a) Use the information in the chart to answer the following questions.

(i) State the stopping distance for a speed of 50 km/h. .... m [1]

(ii) State the speed at which the car stops just in time. .... km/h [1]

(iii) State the speed which gives a braking distance of 35 m. .... km/h [1]

(iv) Tiredness doubles **thinking** distance for some drivers.
Gareth claims that, for these tired drivers travelling at 60 km/h, the stopping distance becomes 90 m.
With the aid of calculations, explain whether you agree with the claim. [3]

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(v) Use the equation:

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

and information from the chart for a car travelling at 60 km/h (17 m/s), to calculate the **thinking time** of an alert driver. [3]

Thinking time = ... s

(b) A car is travelling at 70 km/h on a dry road when it starts to rain causing the road to become **wet**.
Complete the table below.
In each box, add either increases, decreases, or stays the same. [3]

Thinking distance	Braking distance	Stopping distance	Impact speed
....	....	increases	....

(c) Seat belts **and** crumple zones work together to keep the occupants of a car safe in the event of a head-on collision.
Complete the table by placing a tick (✓) in the column that matches with the action.
One has been done as an example. [2]

Action	Seat belt	Crumple zone
Increases the time of the collision		✓
Reduces force on the car		
Prevents driver continuing through the windscreen		

End of questions