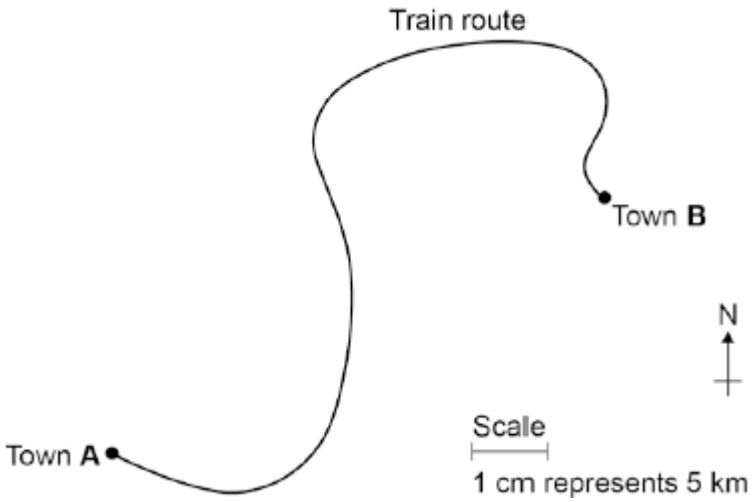
THE DISTANCE-TIME RELATIONSHIP

Q1.

A train travels from town **A** to town **B**.

Figure 1 shows the route taken by the train.
Figure 1 has been drawn to scale.

Figure 1



(a) The distance the train travels between **A** and **B** is not the same as the displacement of the train.

What is the difference between distance and displacement?

_____

_____

_____

(1)

(b) Use **Figure 1** to determine the displacement of the train in travelling from **A** to **B**.

Show how you obtain your answer.

_____

_____

Displacement = _____ km

Direction = _____

(2)

(c) There are places on the journey where the train accelerates without changing speed.

Explain how this can happen.

_____

_____

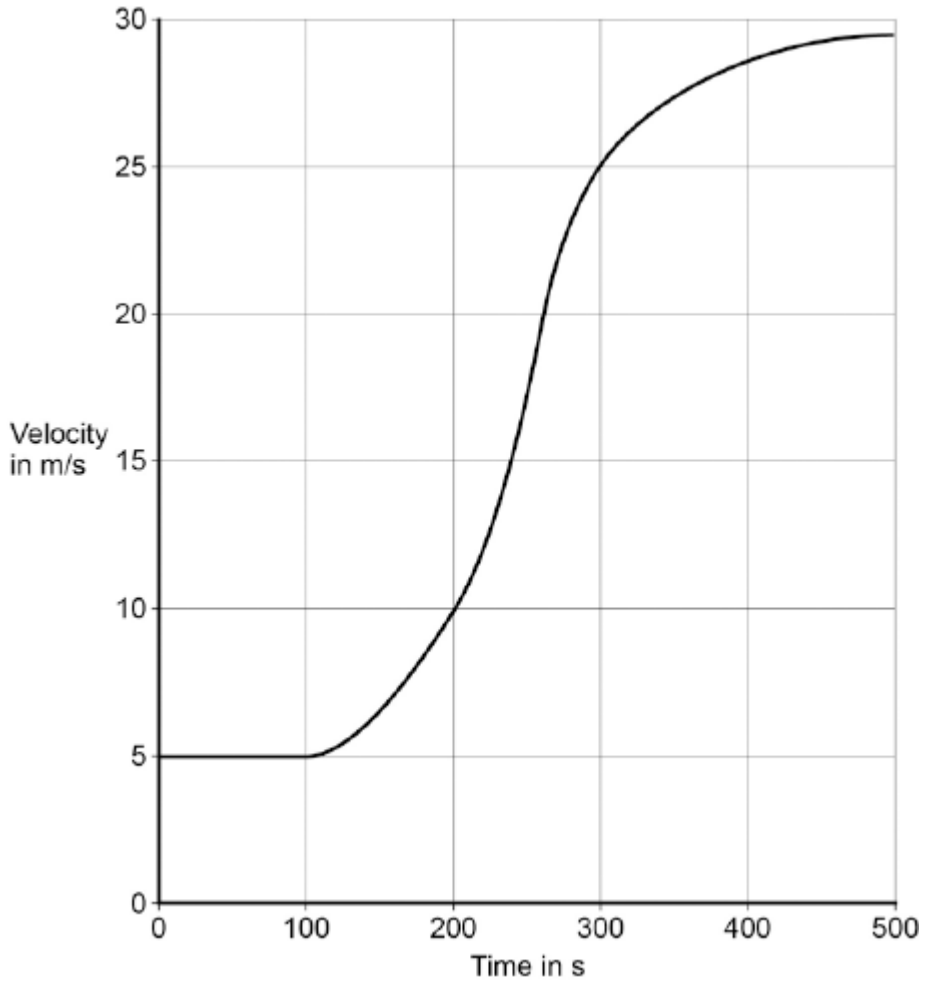
_____

_____

(2)

(d) **Figure 2** shows how the velocity of the train changes with time as the train travels along a straight section of the journey.

Figure 2



Estimate the distance travelled by the train along the section of the journey shown in **Figure 2**.

To gain full marks you must show how you worked out your answer.

_____

_____

_____

_____

Distance = _____ m

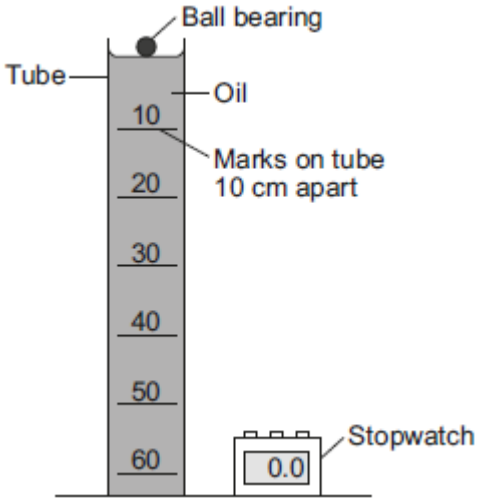
(3)

(Total 8 marks)

Q2.

A student investigated how the speed of a ball bearing changes as the ball bearing falls through a tube of oil.
Figure 1 shows the equipment the student used.

Figure 1



The student measured the time taken for the ball bearing to fall different distances.
Each distance was measured from the top of the oil.

(a) What is likely to have been the main source of error in this investigation?

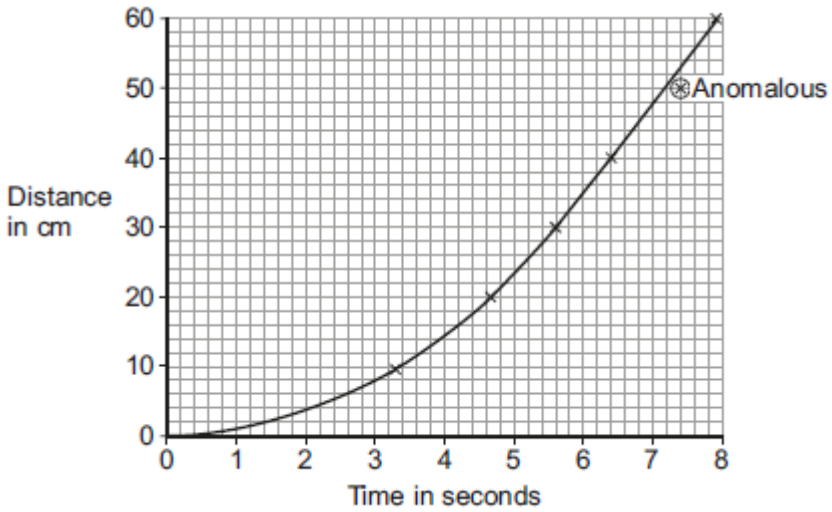
_____

_____

(1)

(b) **Figure 2** shows the student's results plotted as a graph.

Figure 2



(i) The student has identified one of the results as being anomalous.

Use the correct answer from the box to complete the sentence.

after	**as**	**before**

The anomalous result was caused by the stopwatch being started

_____ the ball bearing was released.

(1)

(ii) What can you conclude from the graph about the speed of the ball bearing during the first four seconds?

_____

_____

(1)

(iii) The graph shows that the ball bearing reached its terminal velocity.

Describe how the graph would be used to calculate the terminal velocity of the ball bearing.

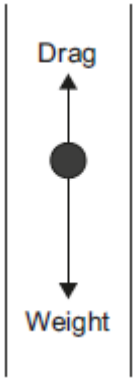
_____

_____

(1)

(iv) The directions of the two forces acting on the ball bearing as it falls through the oil are shown in **Figure 3**.

Figure 3



Explain, in terms of the forces shown in **Figure 3**, why the ball bearing reaches its terminal velocity.

_____

_____

_____

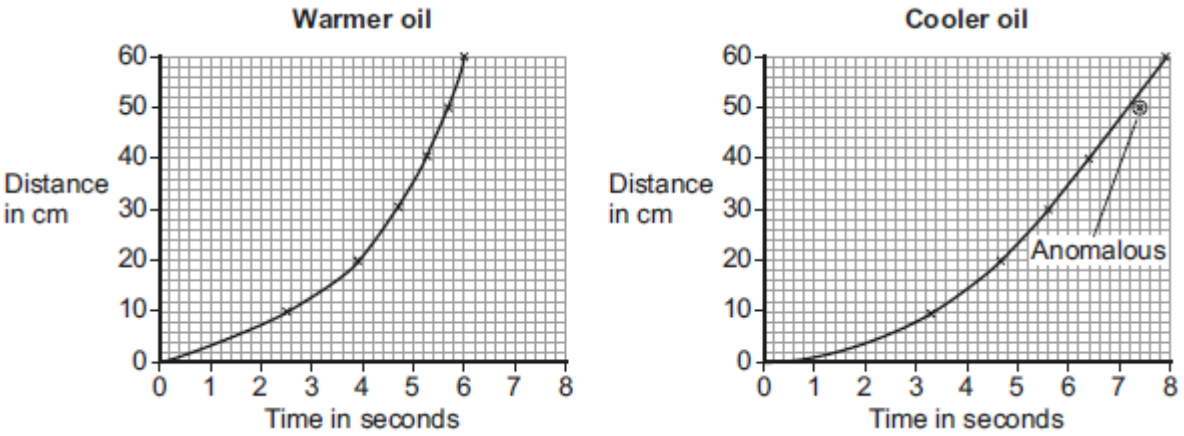
_____

(2)

(c) The student repeated the investigation using warmer oil.

Figure 4 shows the set of results using the warmer oil **and** the set of results using the cooler oil.

Figure 4



Compare the two graphs in **Figure 4**.

Use the correct answer from the box to complete the sentence.

less than	**equal to**	**greater than**

After falling 40 cm, the drag force on the ball bearing in the warmer oil is

_____ the drag force on the ball bearing in the cooler oil.

Explain the reason for your answer.

_____

_____

_____

_____

(3)

(Total 9 marks)

Q3.

A number of different forces act on a moving vehicle.

(a) A car moving at a steady speed has a driving force of 3000 N.

(i) What is the value of the resistive force acting on the car?

Tick (✓) **one** box.

	Tick (✓)
2000 N	
3000 N	
4000 N	

(1)

(ii) What causes most of the resistive force?

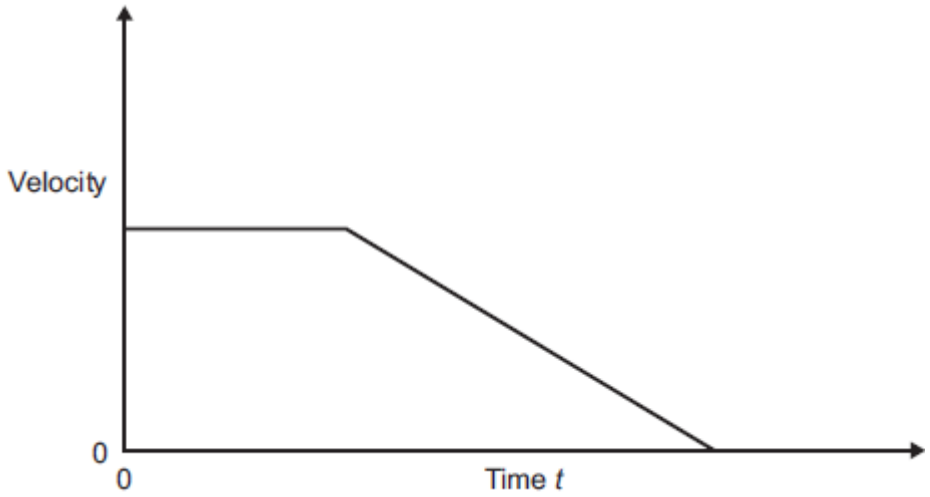
Tick (✓) **one** box.

	Tick (✓)
Air resistance	
Faulty brakes	
Poor condition of tyres	

(1)

(b) A car is moving along a road. The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

The graph shows how the velocity of the car changes with time.



(i) Which feature of the graph represents the negative acceleration of the car?

Tick (✓) **one** box.

	Tick (✓)
The area under the graph	
The gradient of the sloping line	
The intercept on the y-axis	

(1)

(ii) Which feature of the graph represents the distance travelled by the car?

Tick (✓) **one** box.

	Tick (✓)
The area under the graph	
The gradient of the sloping	

line	
The intercept on the y-axis	

(1)

(iii) On a different journey, the car is moving at a **greater** steady speed.

The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

The driver's reaction time and the braking distance are the same as shown the graph above.

On the graph above draw another graph to show the motion of the car.

(3)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Thinking distance and braking distance affect stopping distance.

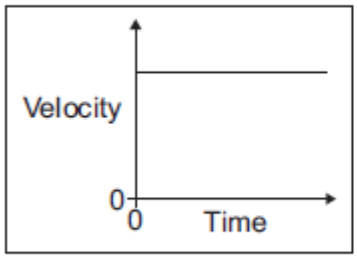
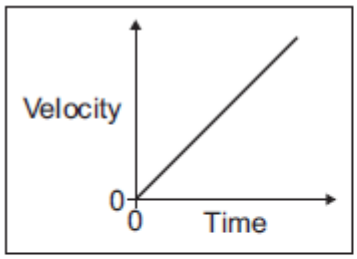
Explain how the factors that affect thinking distance and braking distance affect stopping distance.

(6)

(Total 13 marks)

Q4.

(a) Draw **one** line from each velocity−time graph to the statement describing the motion shown by the graph.

Velocity–time graph	Motion shown by graph
	Constant acceleration
	Not moving
	Constant deceleration
	Constant velocity

(2)

(b) Use the correct answer from the box to complete the sentence.

energy	**momentum**	**speed**

The velocity of an object includes both the _____ of the object
and the direction the object is moving.

(1)

(c) At the start of a race, a horse accelerates from a velocity of 0 m / s to a velocity of 9 m / s in 4 seconds.

(i) Calculate the acceleration of the horse.

_____

_____

Acceleration = _____ m / s^2

(2)

(ii) When the horse accelerates, what, if anything, happens to the air resistance acting against the horse?

Tick (✓) **one** box.

The air resistance decreases ☐

The air resistance is constant ☐

The air resistance increases ☐

(1)

(d) A horse and a pony walk across a field at the same constant speed.

The horse has 4000 joules of kinetic energy.

The pony is **half** the mass of the horse.

What is the kinetic energy of the pony?

Draw a ring around the correct answer

2000 J **4000 J** **8000 J**

Give a reason for your answer.

_____

_____

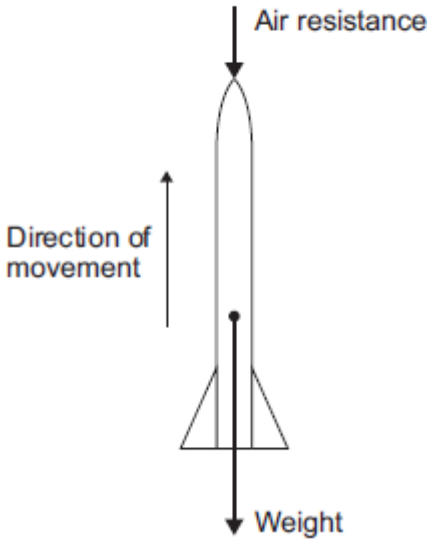
(2)

(Total 8 marks)

Q5.

(a) **Figure 1** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 1



(i) How does the velocity of the rocket change as the rocket moves **upwards**?

_____

Give a reason for your answer.

_____

_____

(2)

(ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

_____

_____

_____

(1)

(b) The speed of the rocket just after being launched is 12 m / s.
The mass of the rocket is 0.05 kg.

(i) Calculate the kinetic energy of the rocket just after being launched.

_____

_____

_____

Kinetic energy = _____ J

(2)

(ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

Maximum gravitational potential energy = _____ J

(1)

(iii) Calculate the maximum height the rocket will reach.

Ignore the effect of air resistance.

Gravitational field strength = 10 N / kg.

_____

_____

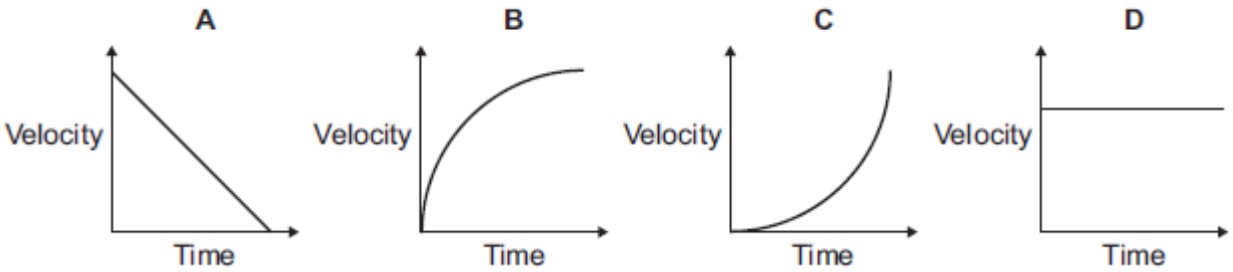
_____

Maximum height = _____ m

(2)

(iv) **Figure 2** shows four velocity−time graphs.

Figure 2



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

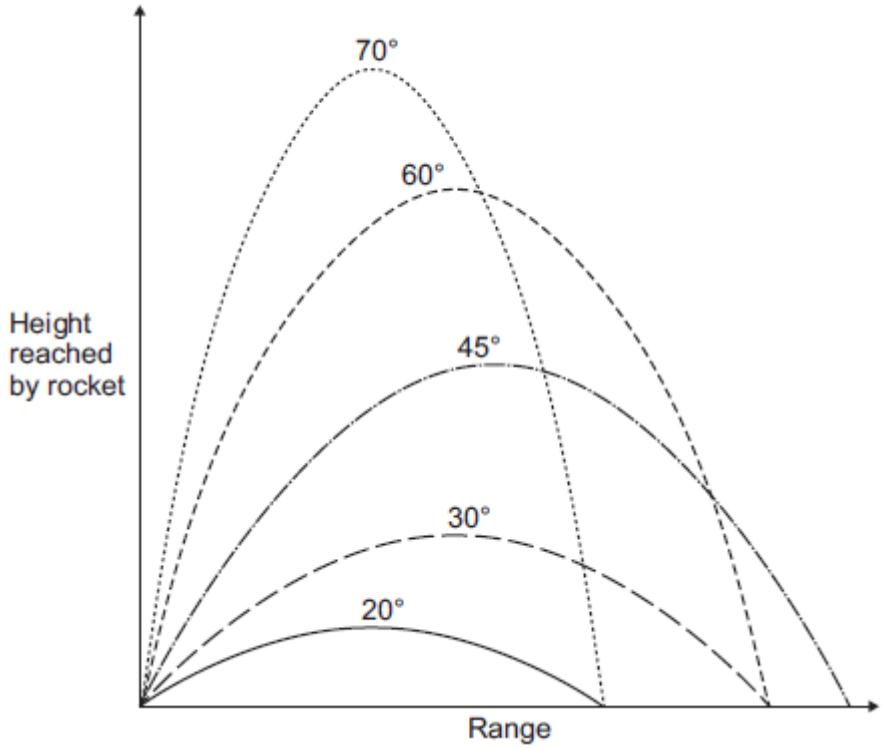
Write the correct answer in the box. ☐

(1)

(c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 3 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 3



What pattern links the angle at which the rocket is launched and the range of the rocket?

_____

_____

_____

_____

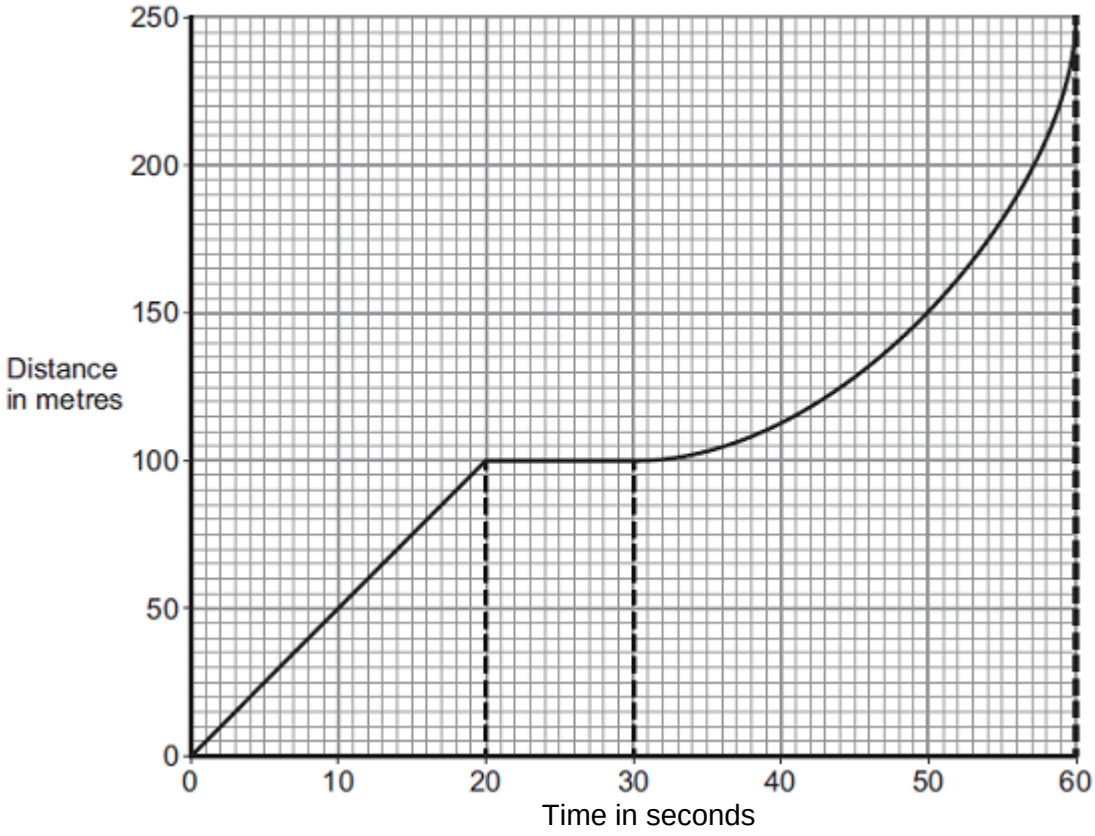
(2)

(Total 11 marks)

Q6.

A bus is taking some children to school.

(a) The bus has to stop a few times. The figure below shows the distance–time graph for part of the journey.



(i) How far has the bus travelled in the first 20 seconds?

Distance travelled = _____ m

(1)

(ii) Describe the motion of the bus between 20 seconds and 30 seconds.

_____

_____

(1)

(iii) Describe the motion of the bus between 30 seconds and 60 seconds.

Tick (✓) **one** box.

	Tick (✓)
Accelerating	
Reversing	

Travelling at constant speed	

(1)

(iv) What is the speed of the bus at 45 seconds?

Show clearly on the figure above how you obtained your answer.

_____

_____

_____

Speed = _____ m / s

(3)

(b) Later in the journey, the bus is moving and has 500 000 J of kinetic energy.

The brakes are applied and the bus stops.

(i) How much work is needed to stop the bus?

_____

Work = _____ J

(1)

(ii) The bus stopped in a distance of 25 m.

Calculate the force that was needed to stop the bus.

_____

_____

Force = _____ N

(2)

(iii) What happens to the kinetic energy of the bus as it is braking?

_____

_____

_____

_____

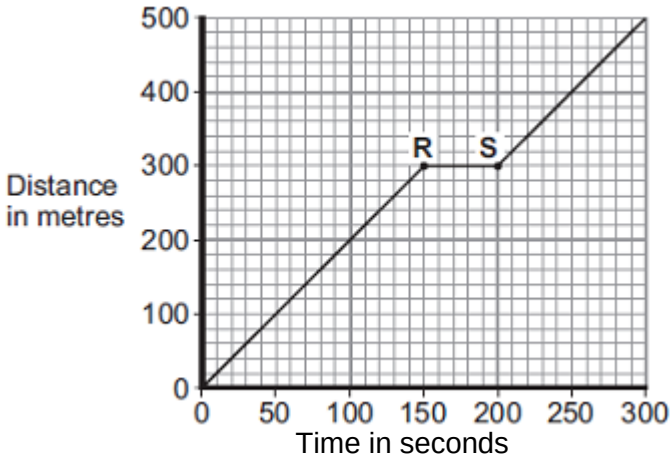
(2)

(Total 11 marks)

Q7.

(a) **Figure 1** shows the distance–time graph for a person walking to a bus stop.

Figure 1



(i) Which **one** of the following statements describes the motion of the person between points **R** and **S** on the graph?

Tick (✓) **one** box.

Not moving ☐

Moving at constant speed ☐

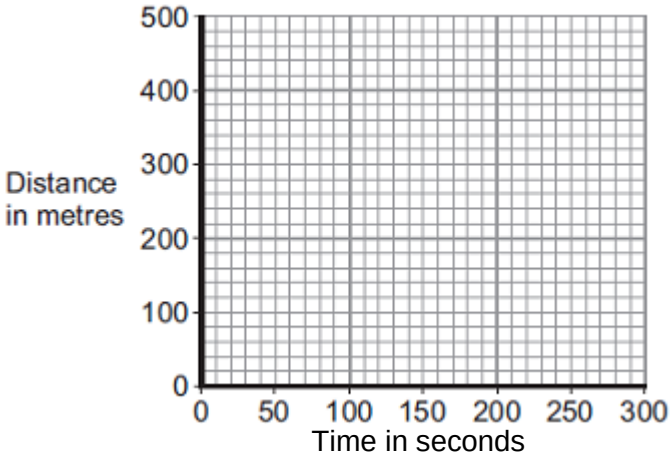
Moving with increasing speed ☐

(1)

(ii) Another person, walking at constant speed, travels the same distance to the bus stop in 200 seconds.

Complete **Figure 2** to show a distance–time graph for this person.

Figure 2



(1)

(b) A bus accelerates away from the bus stop at 2.5 m/s^2.

The total mass of the bus and passengers is 14 000 kg.

Calculate the resultant force needed to accelerate the bus and passengers.

_____

Resultant force = _____ N

(2)

(Total 4 marks)

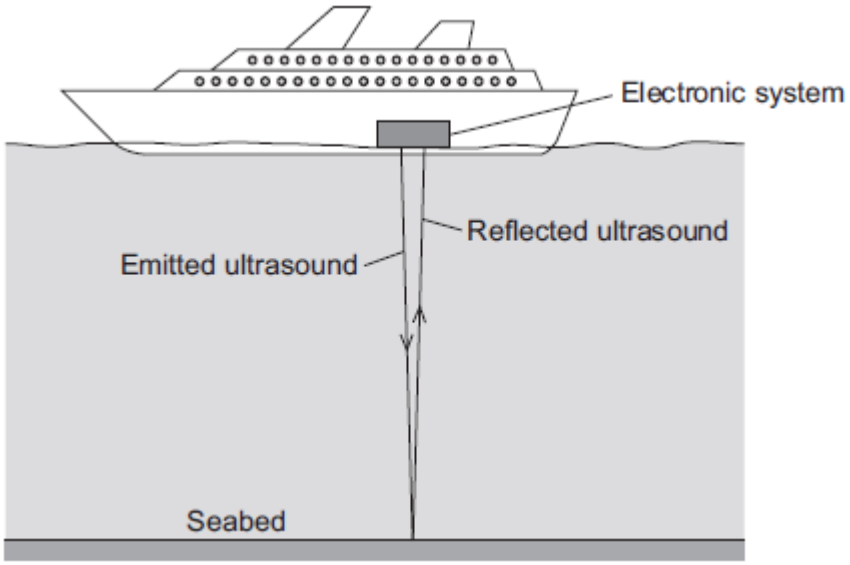
Q8.

(a) What is ultrasound?

(1)

(b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m / s

Depth of water = _____ metres

(3)

(c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

_____

(1)

(d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2

monkeybusinessimages/iStock/Thinkstock

State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

Advantage of CT scanning _____

_____

_____

Disadvantage of CT scanning _____

_____

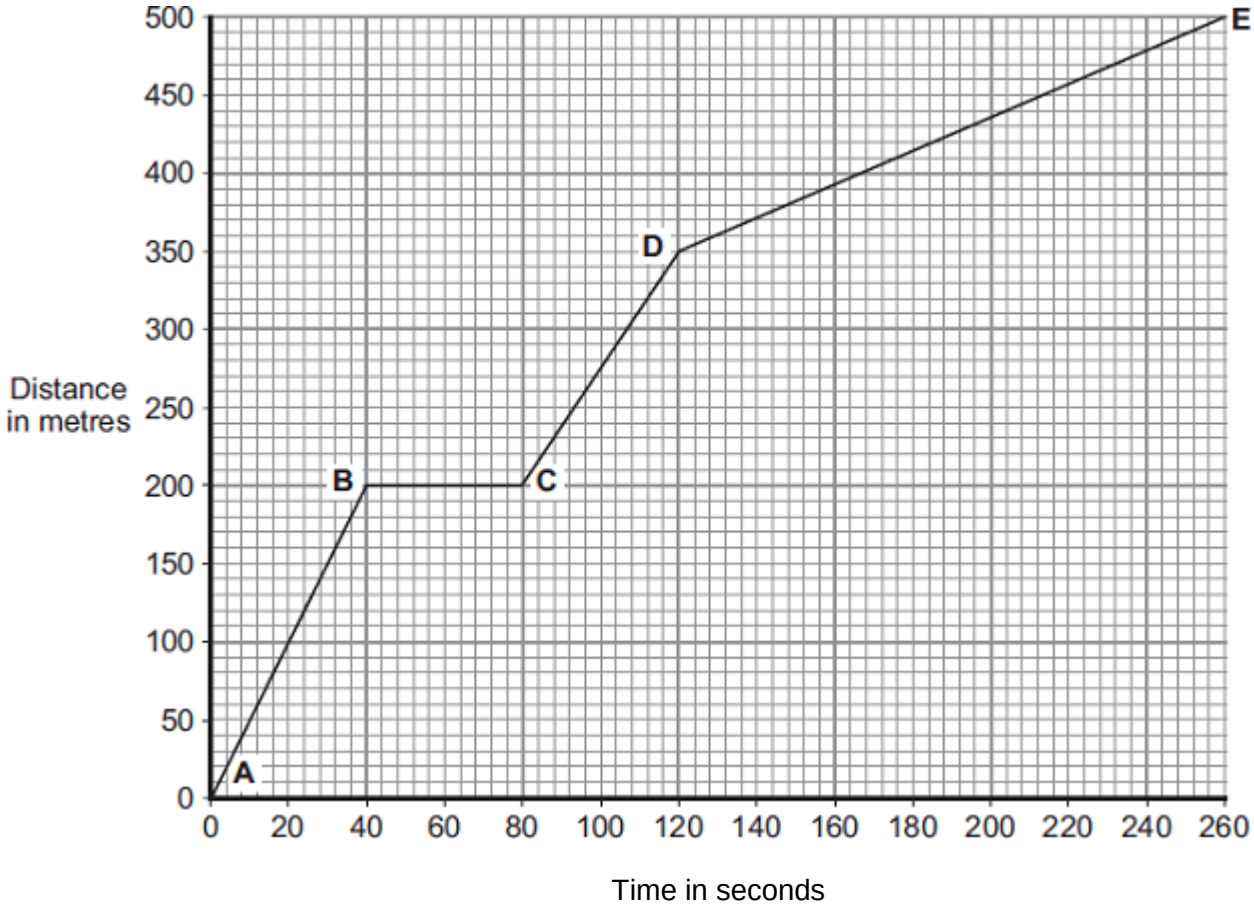
_____

(2)

(Total 7 marks)

Q9.

Part of a bus route is along a high street.
The distance-time graph shows how far the bus travelled along the high street and how long it took.



(a) Between which two points was the bus travelling the slowest?

Put a tick (✓) in the box next to your answer.

Points	Tick (✓)
A – B	
C – D	
D – E	

Give a reason for your answer.

_____

_____

(2)

(b) The bus travels at 5 m/s between points **A** and **B**.
The bus and passengers have a total mass of 16 000 kg.

Use the equation in the box to calculate the momentum of the bus and passengers between points **A** and **B**.

momentum = mass x velocity

Show clearly how you work out your answer.

_____

Momentum = _____ kg m/s

(2)

(c) A cyclist made the same journey along the high street.
The cyclist started at the same time as the bus and completed the journey in 220 seconds. The cyclist travelled the whole distance at a constant speed.

(i) Draw a line on the graph to show the cyclist's journey.

(2)

(ii) After how many seconds did the cyclist overtake the bus?

The cyclist overtook the bus after _____ seconds.

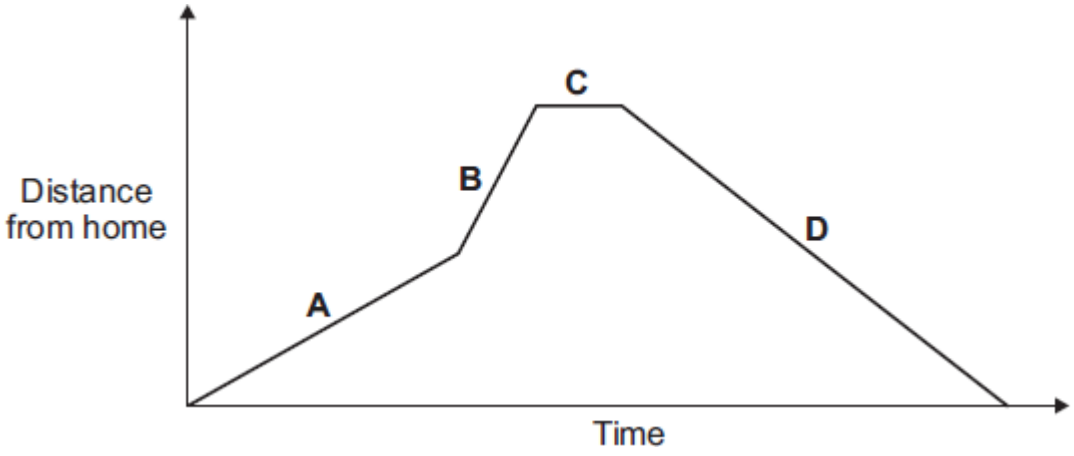
(1)

(Total 7 marks)

Q10.

(a) A person takes their dog for a walk.

The graph shows how the distance from their home changes with time.



Which part of the graph, **A**, **B**, **C** or **D**, shows them walking the fastest?

Write your answer in the box. ☐

Give the reason for your answer.

_____

_____

(2)

(b) During the walk, both the speed and the velocity of the person and the dog change.

How is *velocity* different from *speed*?

_____

_____

(1)

(Total 3 marks)

Q11.

A high-speed train accelerates at a constant rate in a straight line.

The velocity of the train increases from 30 m/s to 42 m/s in 60 seconds.

(a) (i) Calculate the change in the velocity of the train.

_____

Change in velocity = _____ m/s

(1)

(ii) Use the equation in the box to calculate the acceleration of the train.

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

Show clearly how you work out your answer and give the unit.
Choose the unit from the list below.

m/s **m/s^2** **N/kg** **Nm**

_____

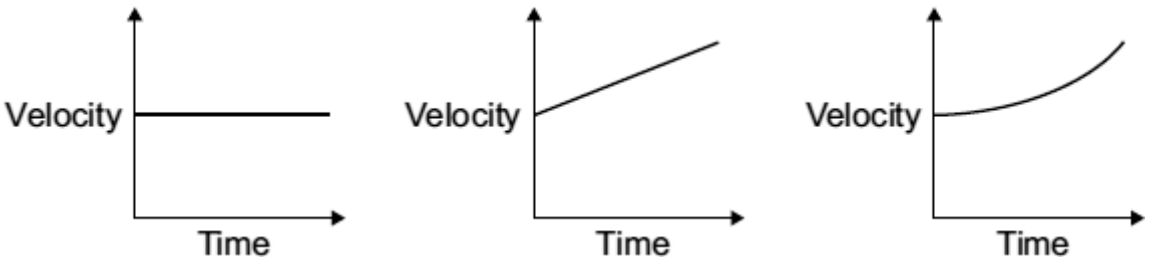
_____

Acceleration = _____

(2)

(b) Which **one** of the graphs, **A**, **B** or **C**, shows how the velocity of the train changes as it accelerates?

Write your answer, **A**, **B** or **C**, in the box.



A **B** **C**

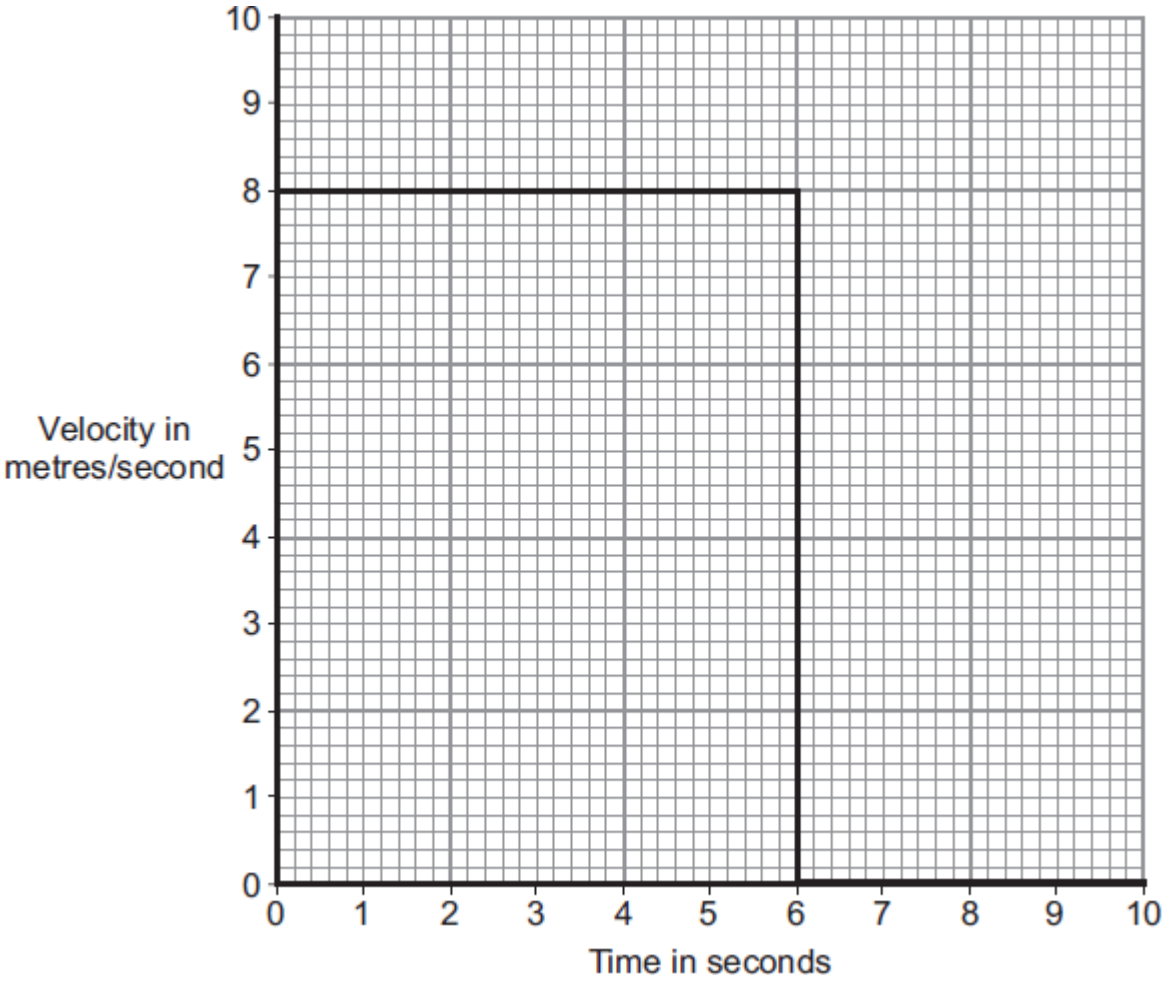
Graph ☐

(1)

(Total 4 marks)

Q12.

The diagram shows the velocity-time graph for an object over a 10 second period.



(a) Use the graph to calculate the distance travelled by the object in 10 seconds.

Show clearly how you work out your answer.

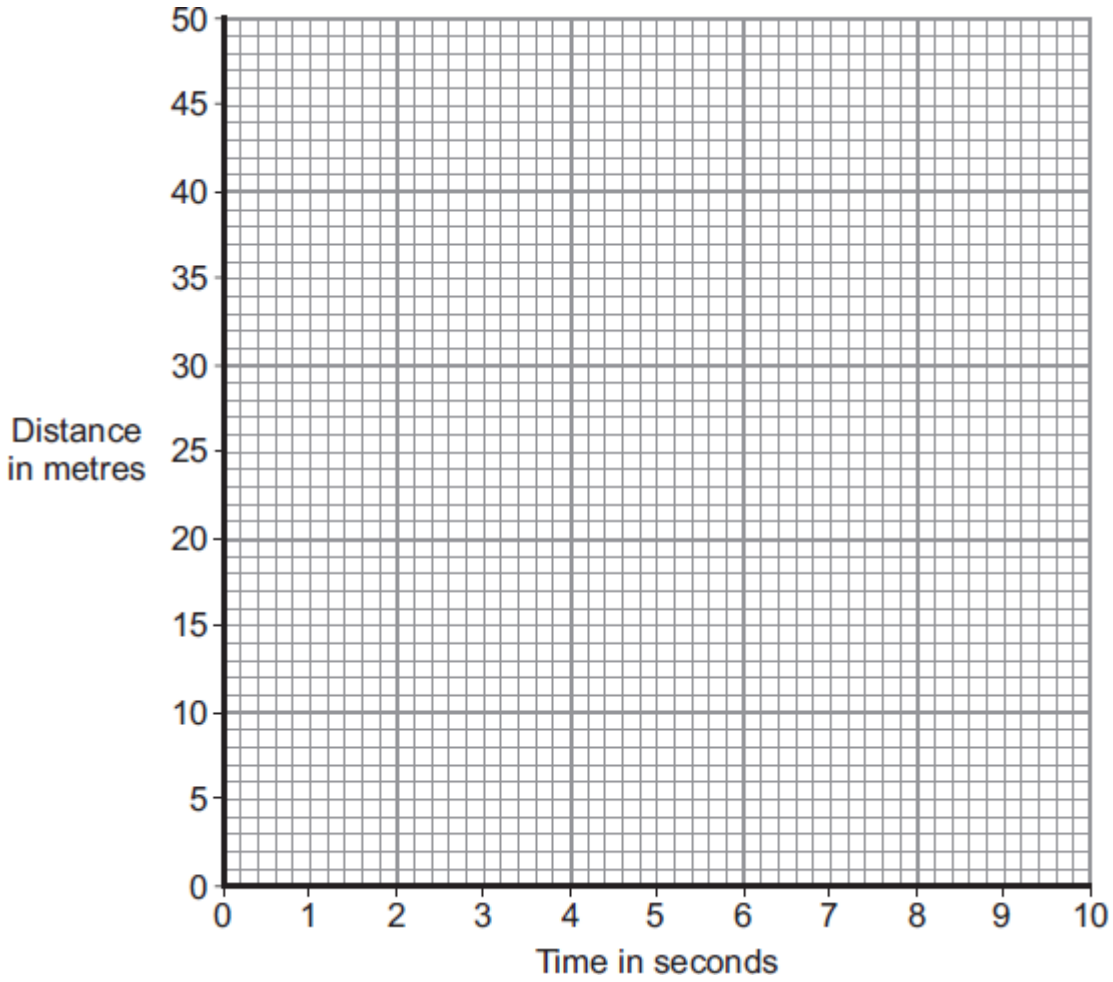
_____

_____

Distance = _____ m

(2)

(b) Complete the distance-time graph for the object over the same 10 seconds.



(2)

(Total 4 marks)

Q13.

A cyclist travelling along a straight level road accelerates at 1.2 m/s^2 for 5 seconds.
The mass of the cyclist and the bicycle is 80 kg.

(a) Calculate the resultant force needed to produce this acceleration.

Show clearly how you work out your answer and give the unit.

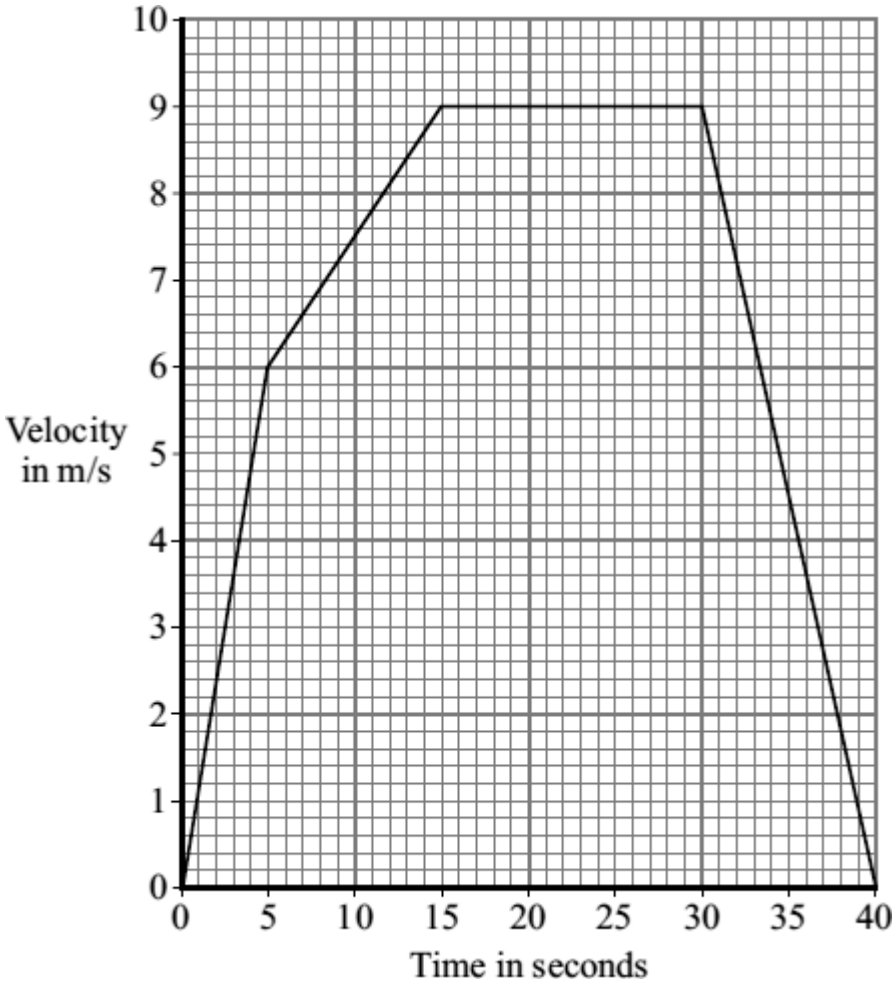
_____

_____

Resultant force = _____

(3)

(b) The graph shows how the velocity of the cyclist changes with time.



(i) Complete the following sentence.

The velocity includes both the speed and the _____ of the cyclist.

(1)

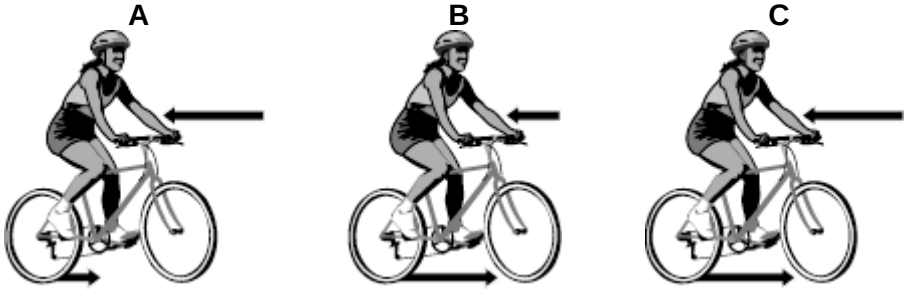
(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

_____

_____

(1)

(iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.



Which **one** of the diagrams, **A**, **B** or **C**, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

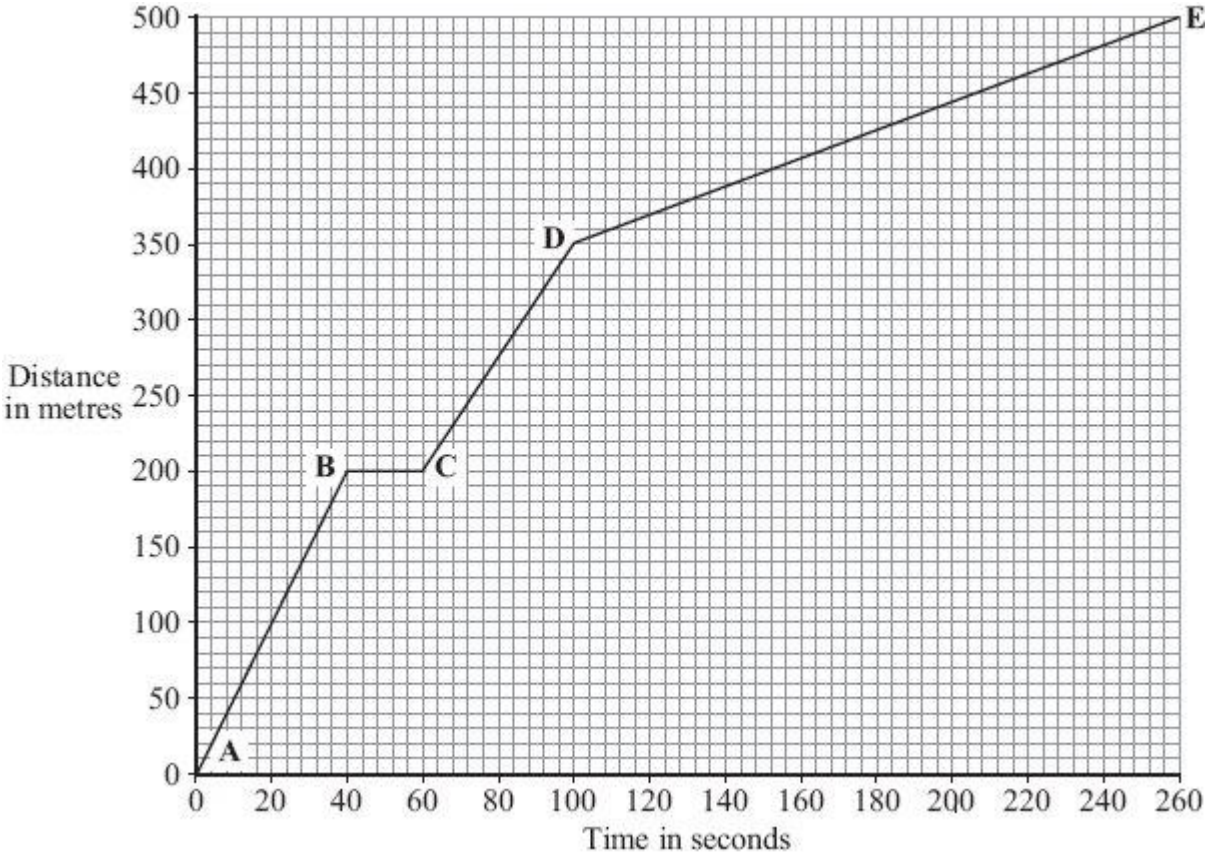
Explain the reason for your choice.

(3)

(Total 8 marks)

Q14.

Part of a bus route is along a high street.
The distance – time graph shows how far the bus travelled along the high street and how long it took.



(a) The bus travels the **slowest** between points **D** and **E**.

How can you tell this from the graph?

(1)

(b) Between which two points was the bus travelling the **fastest**?

Put a tick (✓) in the box next to your answer.

Points	
A – B	
B – C	
C – D	

(1)

(c) There is a bus stop in the high street.
This is marked as point **B** on the graph.

(i) What is the distance between point **A** on the graph and the bus stop?

Distance _____ metres

(1)

(ii) How long did the bus stop at the bus stop?
Show clearly how you work out your answer.

_____

Time = _____ seconds

(2)

(d) A cyclist made the same journey along the high street.
The cyclist started at the same time as the bus and completed the journey in 200 seconds. The cyclist travelled the whole distance at a constant speed.

(i) Draw a line on the graph to show the cyclist's journey.

(2)

(ii) After how many seconds did the cyclist overtake the bus?

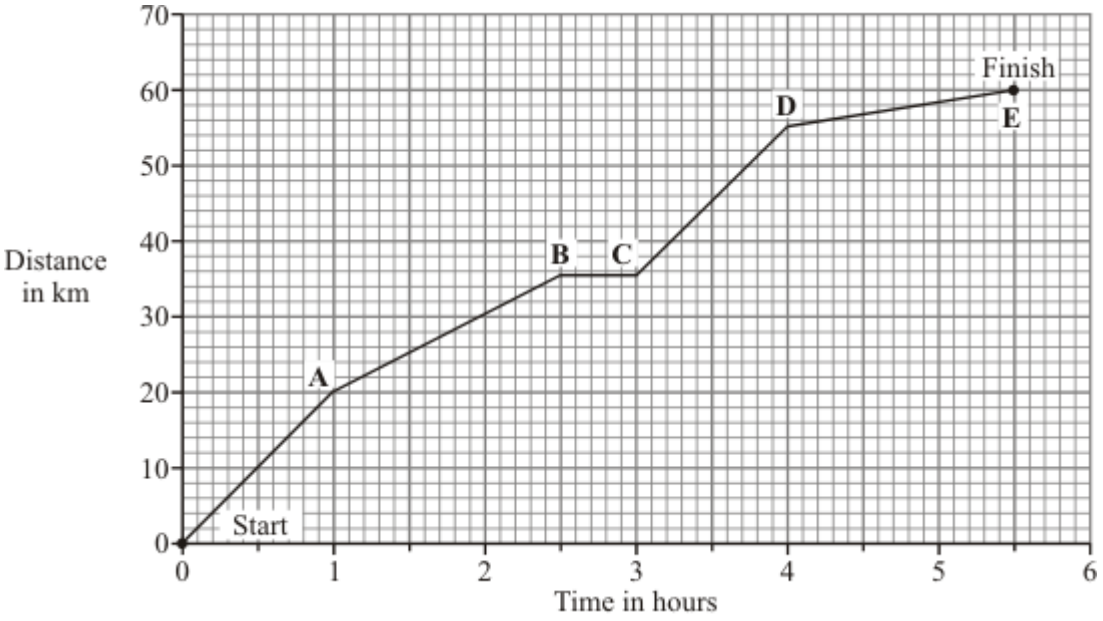
The cyclist overtook the bus after _____ seconds.

(1)

(Total 8 marks)

Q15.

A horse and rider take part in a long distance race. The graph shows how far the horse and rider travel during the race.



(a) What was the distance of the race?

distance = _____ km

(1)

(b) How long did it take the horse and rider to complete the race?

_____

(1)

(c) What distance did the horse and rider travel in the first 2 hours of the race?

distance = _____ km

(1)

(d) How long did the horse and rider stop and rest during the race?

_____

(1)

(e) Not counting the time it was resting, between which two points was the horse moving the slowest?

_____ and _____

Give a reason for your answer.

_____

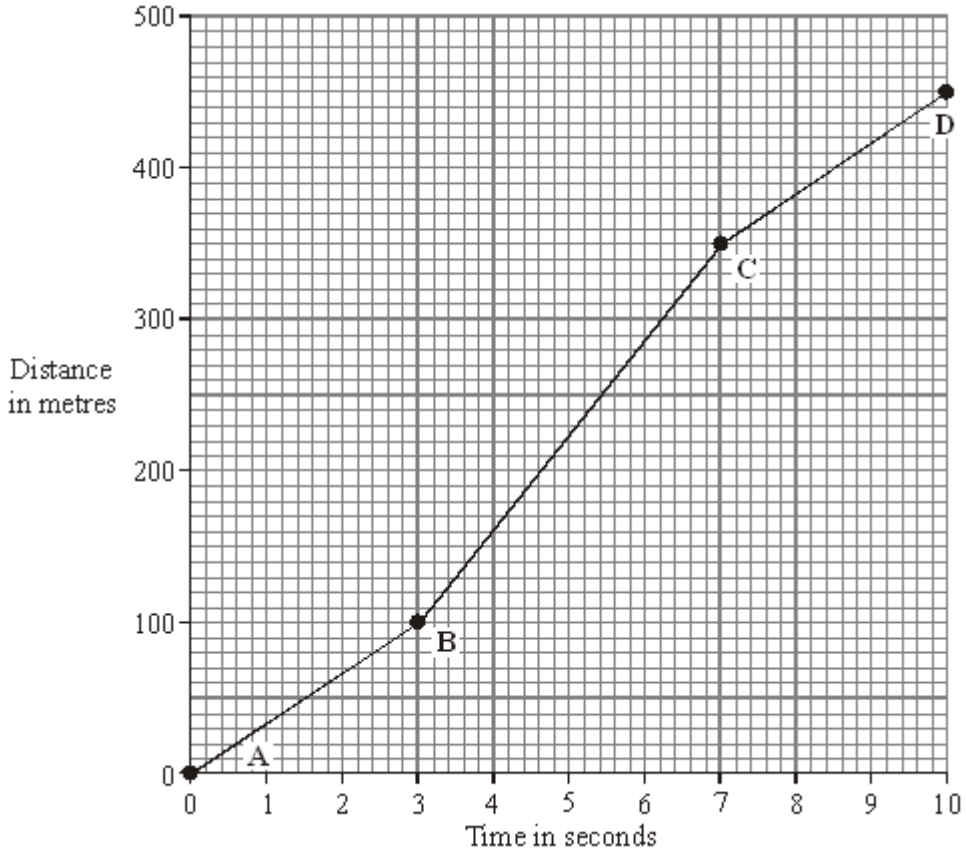
_____

(2)

(Total 6 marks)

Q16.

The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

_____

_____

_____

_____

_____

(3)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

_____

_____

_____

gradient = _____

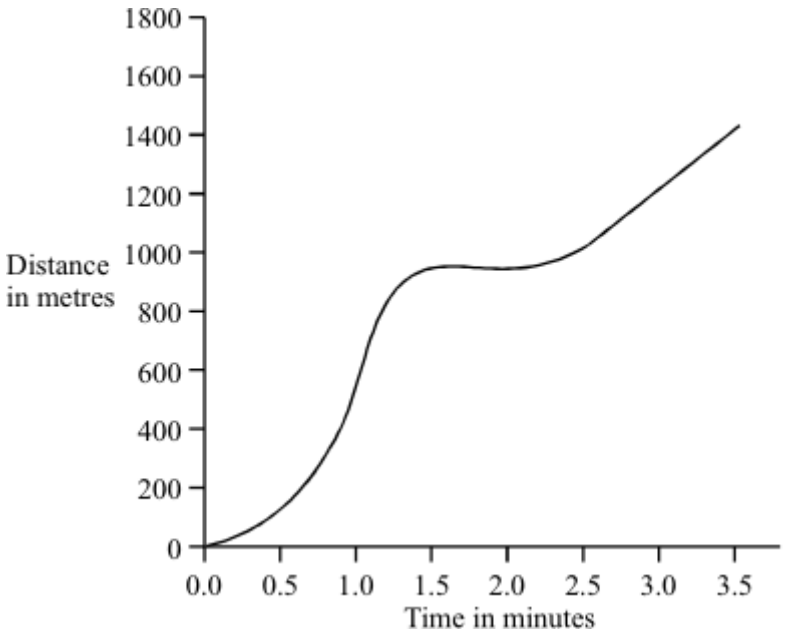
(3)

(Total 6 marks)

Q17.

The graph shows how the distance travelled by a car changes with time during a short

journey.



(i) Describe fully the motion of the car during the first **two** minutes of the journey.

_____

_____

_____

_____

_____

(3)

(ii) During the last minute of the journey the velocity of the car changes although the speed remains constant. How is this possible?

_____

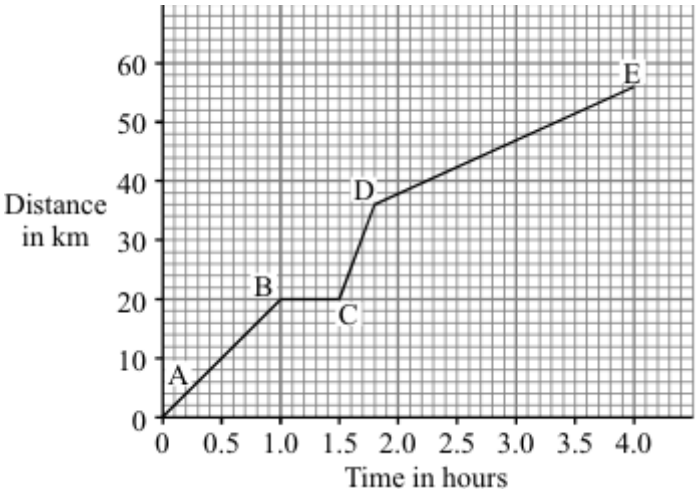
_____

(1)

(Total 4 marks)

Q18.

A cyclist goes on a long ride. The graph shows how the distance travelled changes with time during the ride.



(i) Between which **two** points on the graph was the cyclist moving at the fastest speed?

_____

(1)

(ii) State **one** way cyclists can reduce the air resistance acting on them.

_____

_____

(1)

(iii) How long did the cyclist stop and rest?

_____

(1)

(iv) Write down the equation which links distance, speed and time.

_____

(1)

(v) Calculate, in km/hr, the average speed of the cyclist while moving.

_____

_____

_____

_____

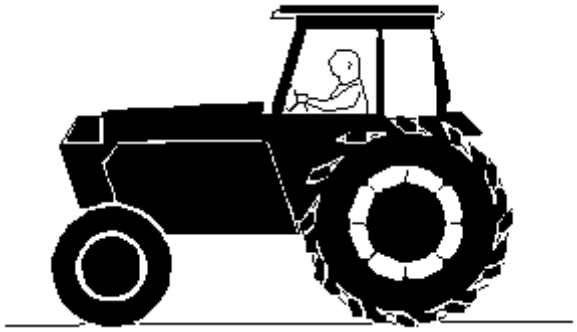
Average speed = _____ km/hr

(3)

(Total 7 marks)

Q19.

(a) The diagram below shows a moving tractor. The forward force from the engine exactly balances the resisting forces on the tractor.



(i) Describe the motion of the tractor.

_____

(ii) The tractor comes to a drier part of the field where the resisting forces are less. If the forward force from the engine is unchanged how, if at all, will the motion of the tractor be affected?

_____

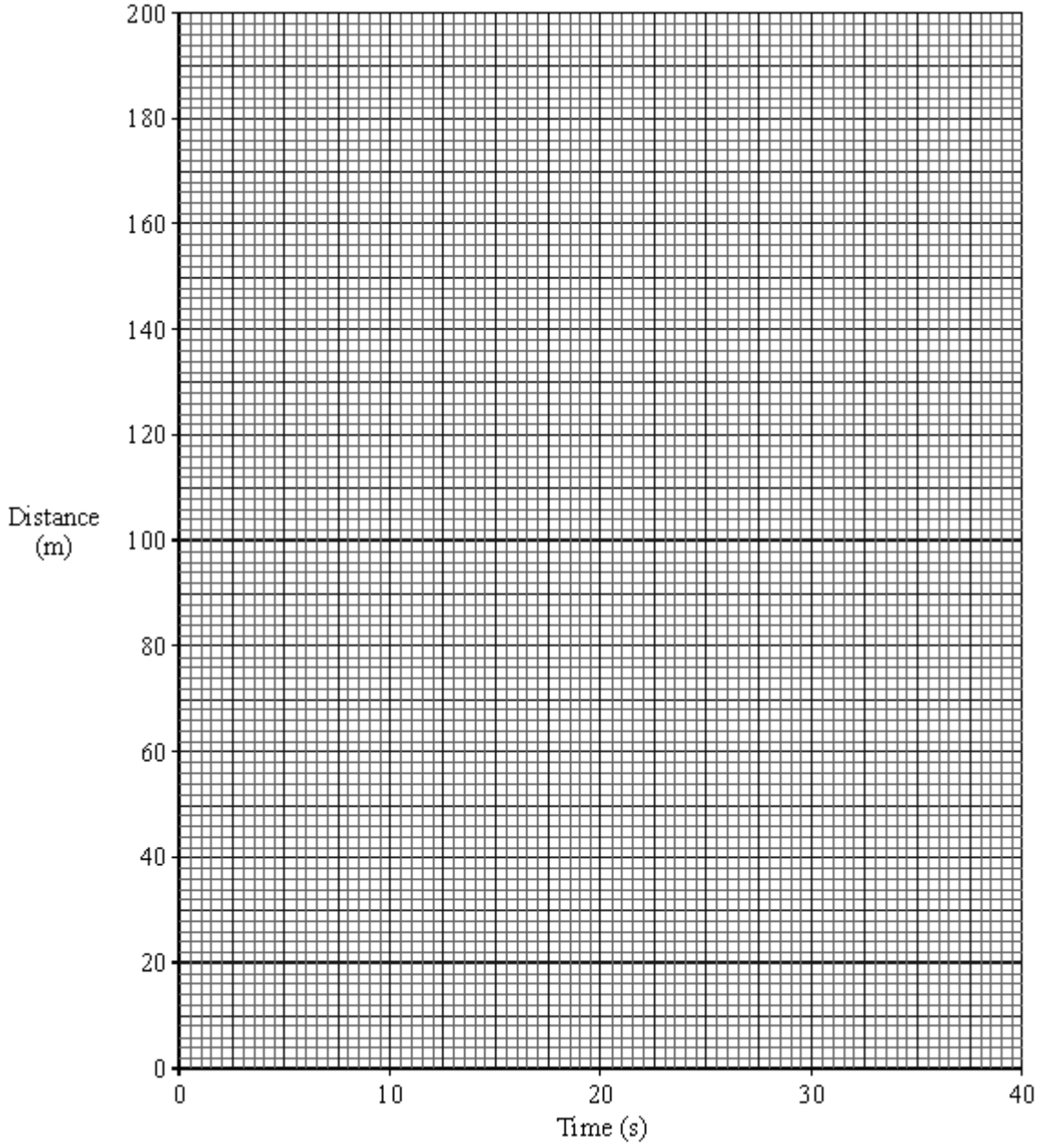
_____

(3)

(b) Two pupils are given the task of finding out how fast a tractor moves across a field. As the tractor starts a straight run across the field the pupils time how long it takes to pass a series of posts which are forty metres apart. The results obtained are shown in the table below.

Distancetravelled (m)	0	40	80	120	160	200
Timetaken (s)	0	8	16	24	32	40

(i) Draw a graph of distance travelled against time taken using the axes on the graph below. Label your graph line A.



(2)

(ii) Calculate the speed of the tractor.

_____

_____

(3)

(c) In another, wetter field there is more resistance to the movement of the tractor. It now travels at 4 m/s.

(i) Calculate the time needed to travel 200m.

_____

_____

_____

(ii) On the graph in part (b) draw a line to represent the motion of the tractor across the second field. Label this line B.

(4)

(d) On a road the tractor accelerates from rest up to a speed of 6 m/s in 15 seconds.

Calculate the acceleration of the tractor.

_____

_____

_____

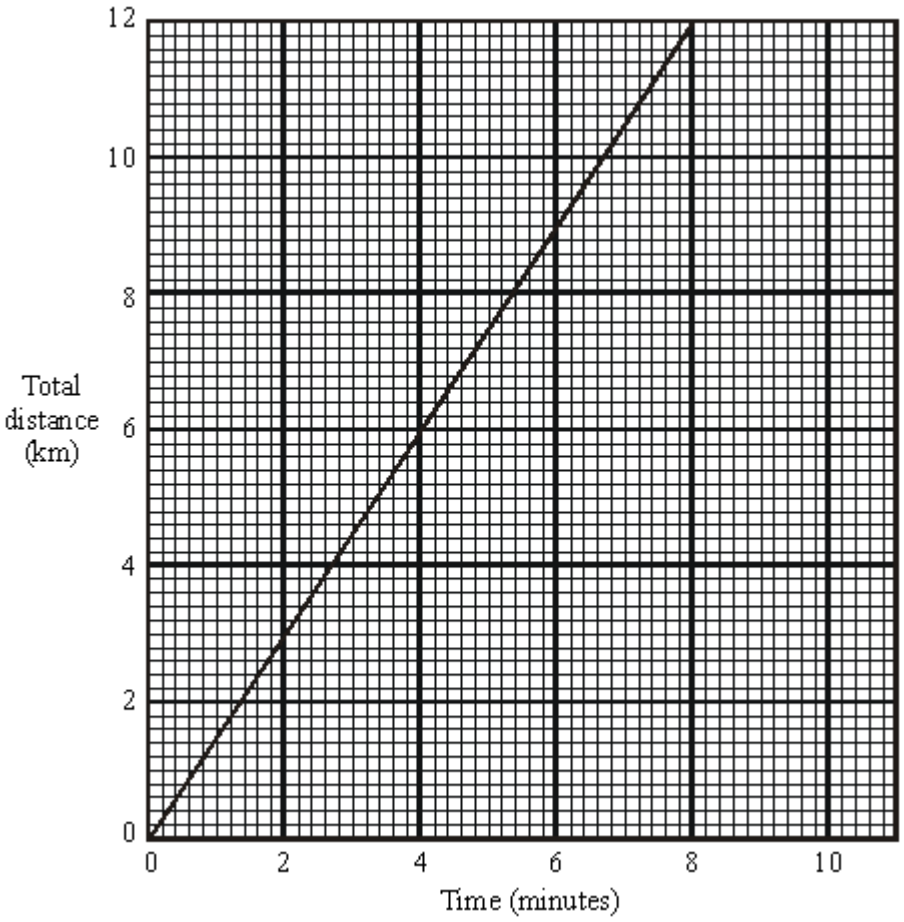
_____ Acceleration = _____ m/s^2

(3)

(Total 15 marks)

Q20.

Below is a distance-time graph for part of a train journey.
The train is travelling at a constant speed.



(a) Use the graph to find

(i) how far the train travels in 2 minutes _____ km.

(ii) how long it takes the train to travel a distance of 10 kilometres

_____ minutes.

(2)

(b) Calculate the speed of the train.

_____

_____

_____

_____

_____

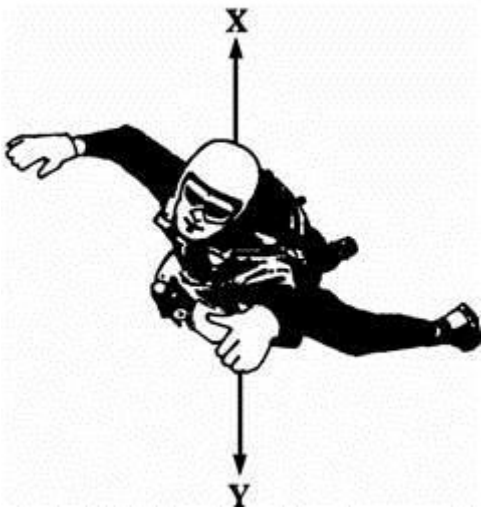
(4)

(Total 6 marks)

Q21.

A sky-diver jumps from a plane.

The sky-diver is shown in the diagram below.



(a) Arrows **X** and **Y** show two forces acting on the sky-diver as he falls.

(i) Name the forces **X** and **Y**.

X _____

Y _____

(2)

(ii) Explain why force **X** acts in an upward direction.

_____

_____

(1)

(iii) At first forces **X** and **Y** are unbalanced.

Which of the forces will be bigger? _____

(1)

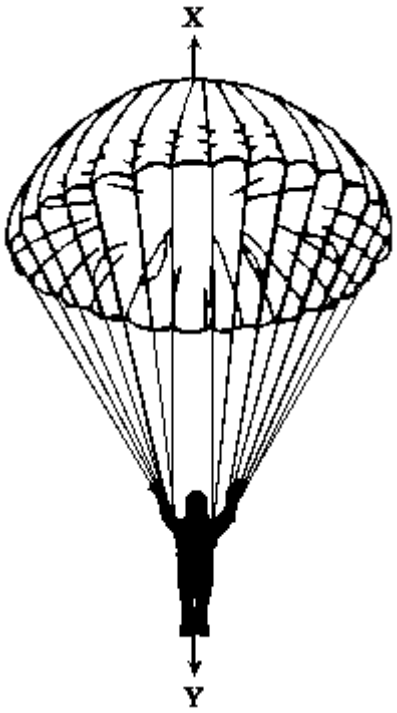
(iv) How does this unbalanced force affect the sky-diver?

_____

(2)

(b) After some time the sky-diver pulls the rip cord and the parachute opens.

The sky-diver and parachute are shown in the diagram below.



After a while forces **X** and **Y** are balanced.

Underline the correct answer in each line below.

Force **X** has

increased / stayed the same / decreased.

Force **Y** has

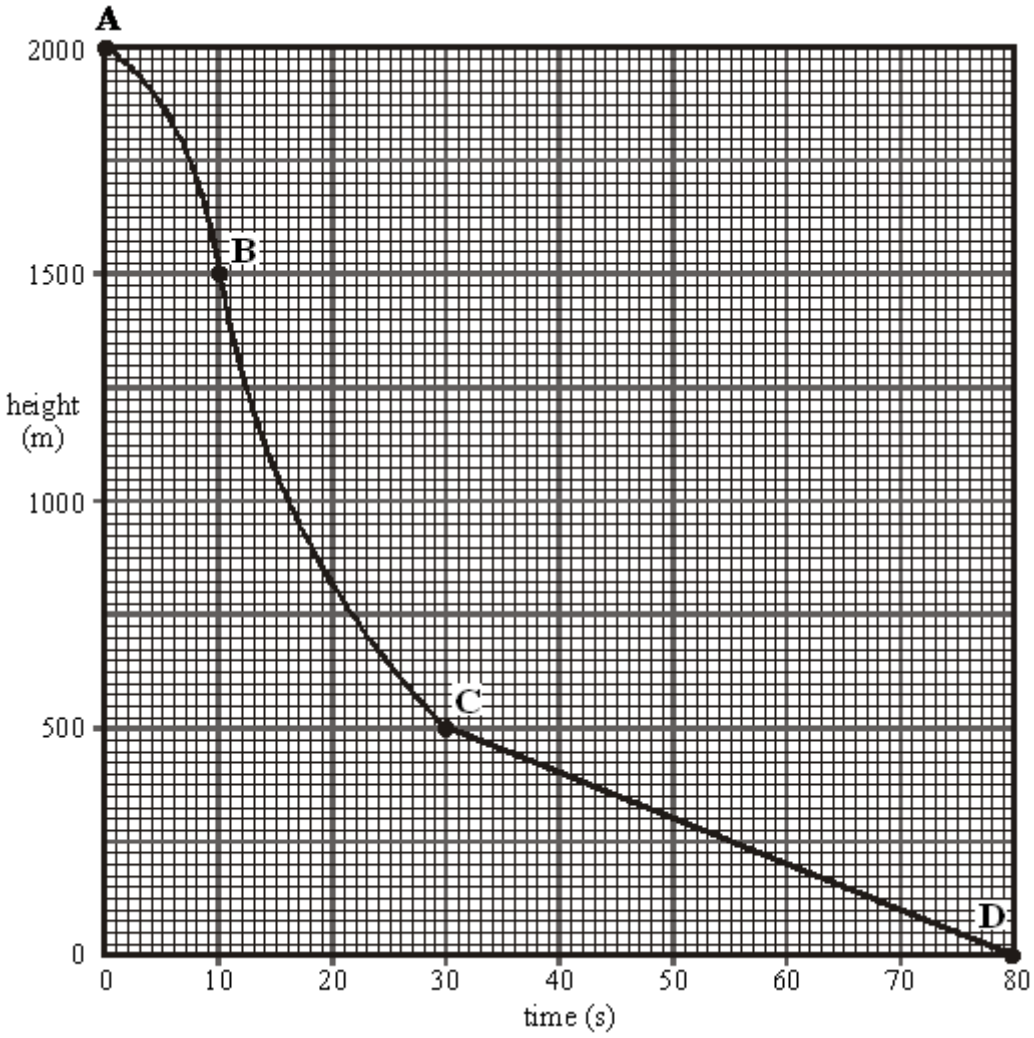
increased / stayed the same / decreased.

The speed of the sky-diver will

increase / stay the same / decrease.

(3)

(c) The graph below shows how the height of the sky-diver changes with time.



(i) Which part of the graph, **AB**, **BC** or **CD** shows the sky-diver falling at a constant speed?

_____

(1)

(ii) What distance does the sky-diver fall at a constant speed?

Distance _____ m

(1)

(iii) How long does he fall at this speed?

Time _____ s

(1)

(iv) Calculate this speed.

_____

_____

_____

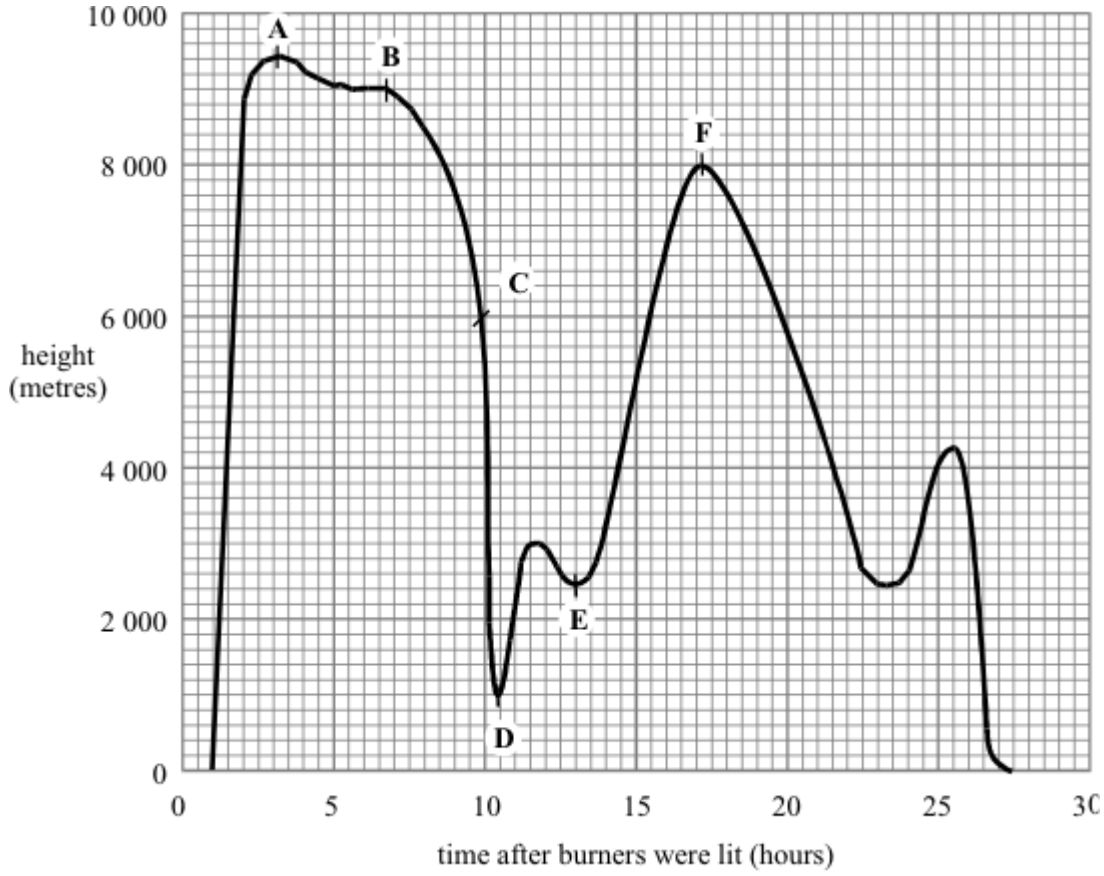
Speed _____ m/s

(2)

(Total 14 marks)

Q22.

A hot air balloon called Global Challenger was used to try to break the record for travelling round the world.
The graph shows how the height of the balloon changed during the flight.



The balloon took off from Marrakesh one hour after the burners were lit and climbed rapidly.

(a) Use the graph to find:

(i) the maximum height reached.

Maximum height _____ metres.

(ii) the total time of the flight.

Total time _____ hours.

(2)

(b) Several important moments during the flight are labelled on the graph with the letters **A**, **B**, **C**, **D**, **E** and **F**.
At which of these moments did the following happen?

(i) The balloon began a slow controlled descent to 2500 metres.

_____

(ii) The crew threw out all the cargo on board in order to stop a very rapid descent.

_____

(iii) The balloon started to descend from 9000 metres.

_____

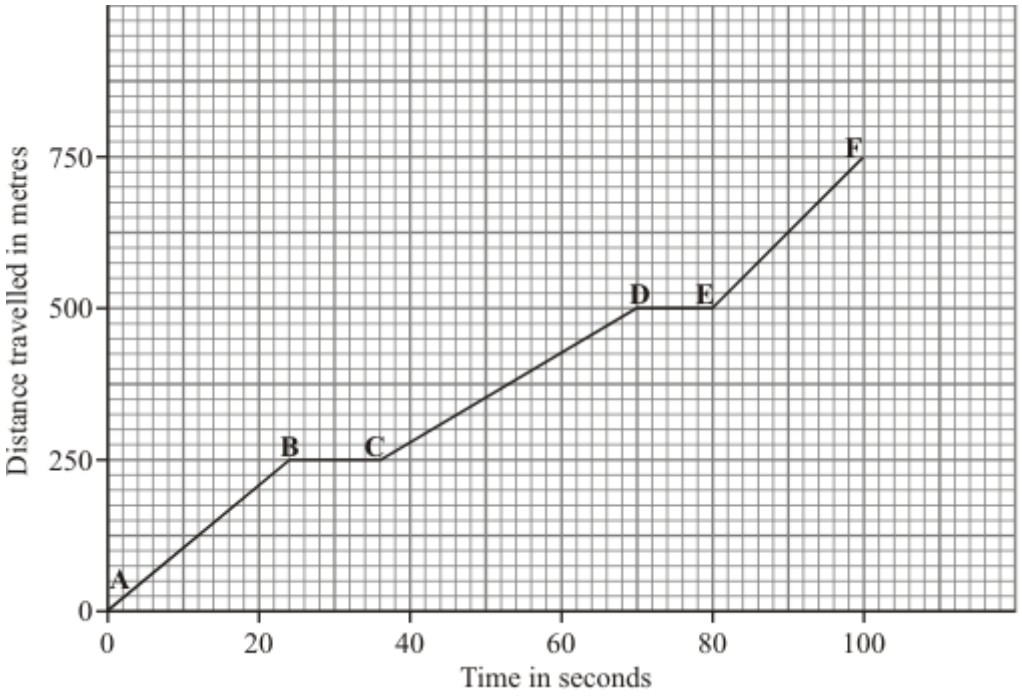
(3)

(Total 5 marks)

Q23.

This question is about a car travelling through a town.

(a) The graph shows how far the car travelled and how long it took.



(i) Between which points was the car travelling fastest? Tick (✓) your answer.

Points	Tick (✓)
A – B	
B – C	
C – D	
D – E	
E – F	

(1)

(ii) Between which points was the car stationary?

_____

_____

(1)

(b) Complete the sentences by writing the correct words in the spaces.

When a car has to stop, the **overall** stopping distance is greater if:

- the car is poorly maintained;
- there are adverse weather conditions;
- the car is travelling _____ ;
- the driver's reactions are _____ .

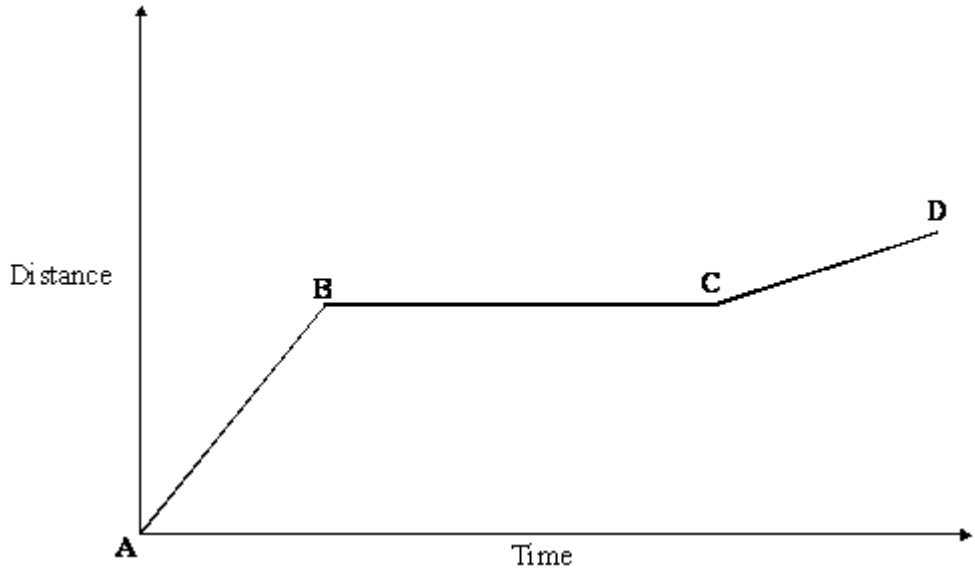
Also, the greater the speed of the car, then the greater the braking _____ needed to stop in a certain time.

(3)

(Total 5 marks)

Q24.

The graph shows the distance a person walked on a short journey.



(a) Choose from the phrases listed to complete the statements which follow. You may use each statement once, more than once or not at all.

standing still

walking at constant speed

walking with an increasing speed

walking with a decreasing speed

(i) Between points **A** and **B** the person is

_____

(1)

(ii) Between points **B** and **C** the person is

_____

(1)

(b) Complete the sentence.

You can tell that the speed of the person between points **A** and **B** is _____

than the speed between points **C** and **D** because _____

_____

(2)

(c) Write the equation which relates distance, speed and time.

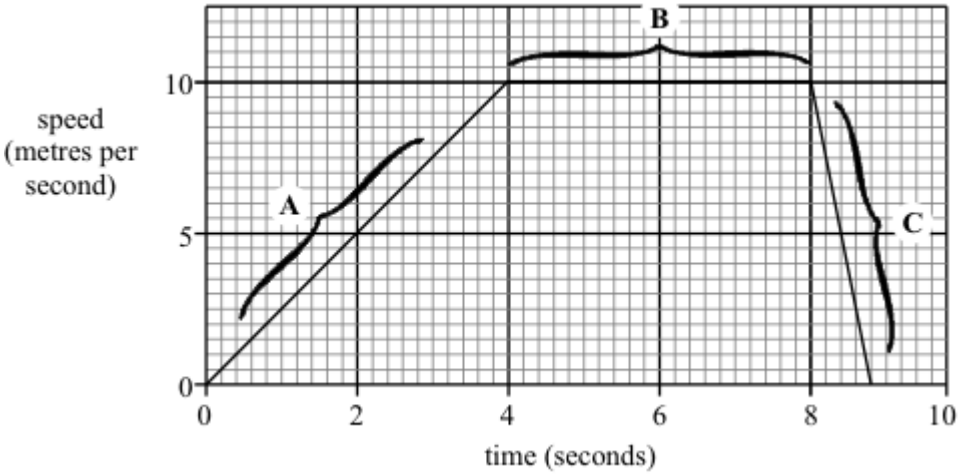
_____

(1)

(Total 5 marks)

Q25.

The graph shows the speed of a runner during an indoor 60 metres race.



(a) Choose words from this list to complete the sentences below.

moving at a steady speed **slowing down**

speeding up **stopped**

Part **A** of the graph shows that the runner is _____

Part **B** of the graph shows that the runner is _____

Part **C** of the graph shows that the runner is _____

(3)

(b) Calculate the acceleration of the runner during the first four seconds.
(Show your working.)

_____

_____

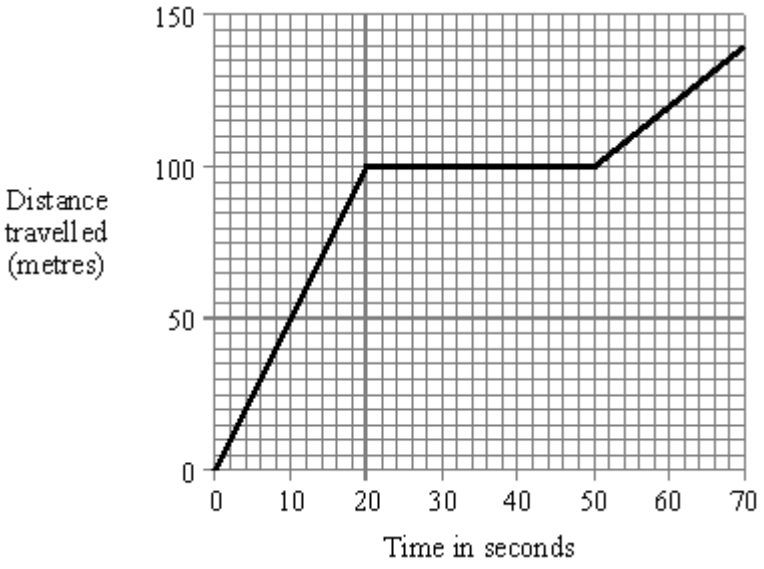
_____

(3)

(Total 6 marks)

Q26.

A child goes out to visit a friend.
The graph shows the child's journey.



(a) Calculate the child's average speed for the whole journey.
[Show your working and give the units in your answer.]

_____

_____

(3)

(b) How many times faster is the child travelling in part A of the graph than in part C?
[You should show how you obtained your answer.]

_____

_____

_____

(2)

(Total 5 marks)