AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.5.6.1.5 ACCELERATION (PACK 1)

SCORE	PERCENTAGE
/285	%

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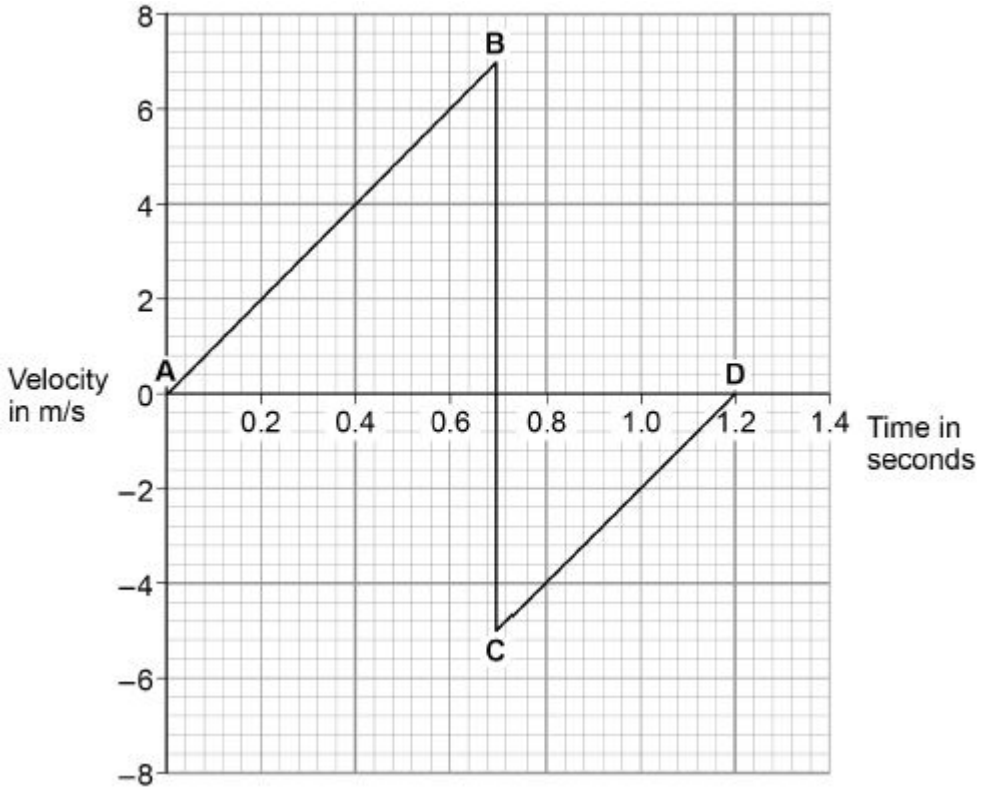
Q1.

A child drops a ball.

The ball hits the ground and bounces.

The graph below shows the velocity-time graph for the ball from when the ball is dropped until when the ball reaches the top of its first bounce.

Air resistance has been ignored.



(a) Describe the motion of the ball between points **A** and **B** on the graph above.

_____

_____

_____

_____

(2)

(b) What direction is the ball moving between points **C** and **D** on the graph above?

_____

(1)

(c) The ball and the Earth form a system.

What is meant by ‘a system’?

Tick **one** box.

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A group of objects that interact. ☐

Objects with big differences in mass. ☐

Objects with gravitational potential energy. ☐

(1)

(d) When the ball hits the ground, energy is transferred from the ball to the Earth.

Explain how the data in the graph above shows this energy transfer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

Q2.

(a) **Figure 1** shows an aircraft flying at a constant velocity and at a constant height above the ground.

Figure 1



Complete the free body diagram in **Figure 2** to show the other two forces acting on the aircraft.

Figure 2

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(2)

(b) A small aircraft accelerated down a runway at 4.0 m/s^2

The aircraft started from rest and reached a speed of 34 m/s just before take-off.

Calculate the distance the aircraft travelled while accelerating.

Give your answer to 2 significant figures.

_____

_____

_____

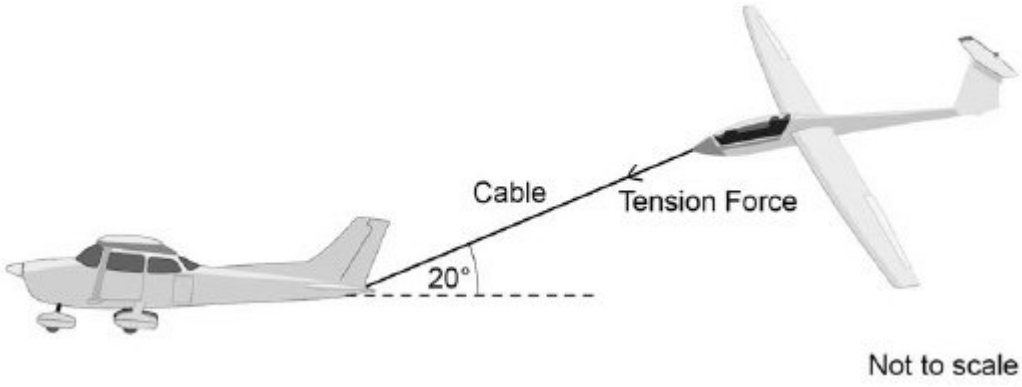
_____

Distance = _____ m

(4)

(c) **Figure 3** shows the small aircraft being used to tow a glider.

Figure 3



The tension force in the cable can be resolved into a horizontal component and a vertical component.

The tension in the cable is 2000 N

The cable makes an angle of 20° with the horizontal.

Draw a vector diagram to determine the magnitude of the two components of the tension force in the cable.

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Magnitude of the horizontal component = _____ N

Magnitude of the vertical component = _____ N

(1)

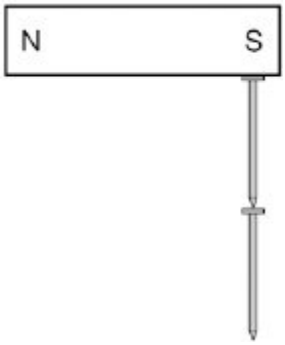
(Total 10 marks)

Q3.

Figure 1 shows two iron nails hanging from a bar magnet.

The iron nails which were unmagnetised are now magnetised.

Figure 1



(a) Complete the sentence.

Use a word from the box.

forced	**induced**	**permanent**

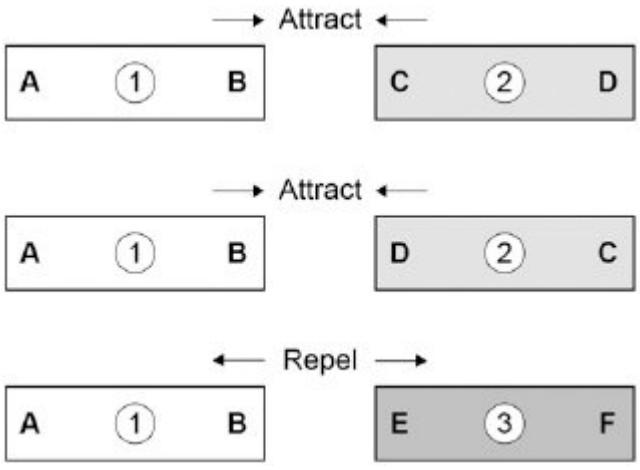
The iron nails have become _____ magnets.

(1)

(b) Each of the three metal bars in **Figure 2** is either a bar magnet or a piece of unmagnetised iron.

The forces that act between the bars when different ends are placed close together are shown by the arrows.

Figure 2



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Which **one** of the metal bars is a piece of unmagnetised iron?

Tick **one** box.

Bar 1 ☐

Bar 2 ☐

Bar 3 ☐

Give the reason for your answer.

_____

_____

(2)

(c) A student investigated the strength of different fridge magnets by putting small sheets of paper between each magnet and the fridge door.

The student measured the maximum number of sheets of paper that each magnet was able to hold in place.

Why was it important that each small sheet of paper had the same thickness?

_____

_____

_____

(1)

(d) Before starting the investigation the student wrote the following hypothesis:

'The bigger the area of a fridge magnet the stronger the magnet will be.'

The student's results are given in the table below.

Fridge magnet	**Area of magnet in mm²**	**Number of sheets of paper held**
A	40	20
B	110	16
C	250	6
D	340	8
E	1350	4

Give **one** reason why the results from the investigation **do not** support the student's hypothesis.

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_____

_____

(1)

(Total 5 marks)

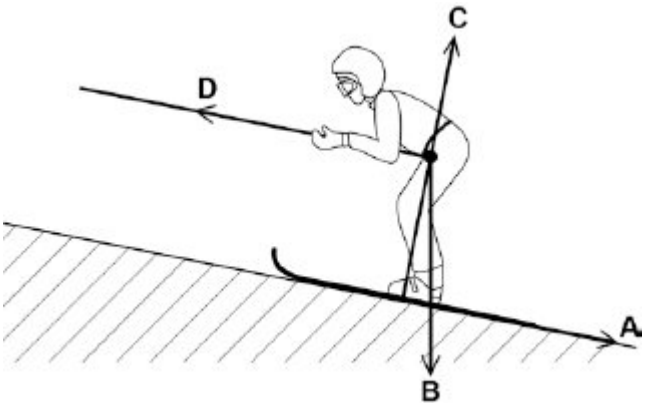
Q4.

Figure 1 shows a skier using a drag lift.

The drag lift pulls the skier from the bottom to the top of a ski slope.

The arrows, **A**, **B**, **C** and **D** represent the forces acting on the skier and her skis.

Figure 1



(a) Which arrow represents the force pulling the skier up the slope?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(b) Which arrow represents the normal contact force?

Tick **one** box.

A ☐

B ☐

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C ☐

D ☐

(1)

(c) The drag lift pulls the skier with a constant resultant force of 300N for a distance of 45 m.

Use the following equation to calculate the work done to pull the skier up the slope.

work done = force × distance

_____

_____

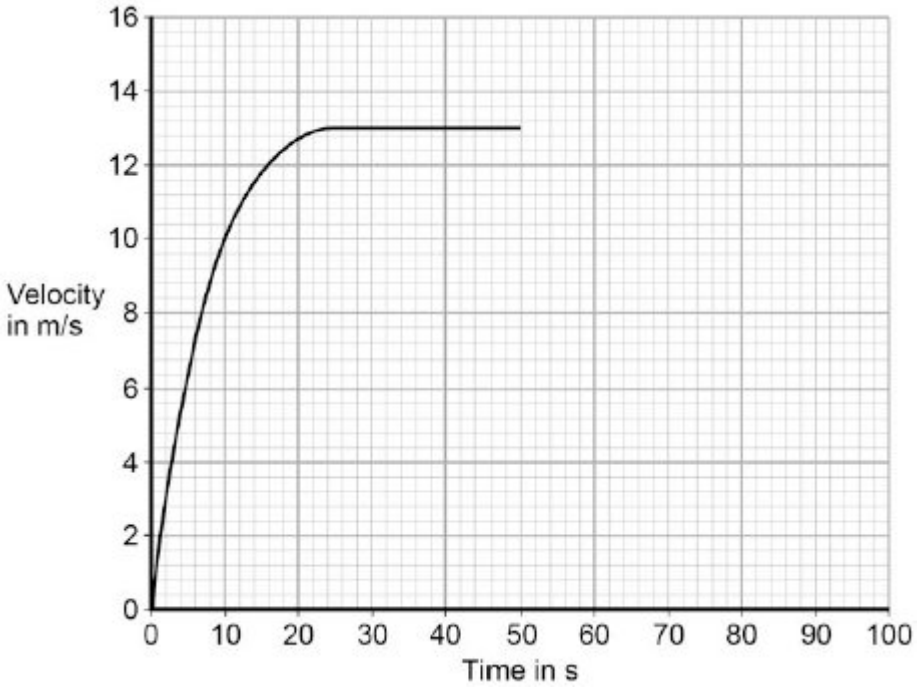
Work done = _____ J

(2)

(d) At the top of the slope the skier leaves the drag lift and skis back to the bottom of the slope.

Figure 2 shows how the velocity of the skier changes with time as the skier moves down the slope.

Figure 2



After 50 seconds the skier starts to slow down.

The skier decelerates at a constant rate coming to a stop in 15 seconds.

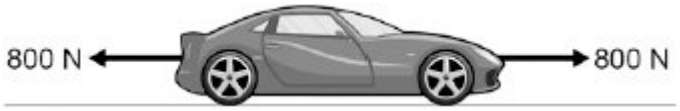
Draw a line on **Figure 2** to show the change in velocity of the skier as she slows down and comes to a stop.

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(2)
(Total 6 marks)

Q5.

The figure below shows the horizontal forces acting on a car.



(a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down. ☐

It will be stationary. ☐

It will have a constant speed. ☐

It will be speeding up. ☐

(1)

(b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time ☐

distance travelled = speed × time ☐

distance travelled = speed − time ☐

distance travelled = speed ÷ time ☐

(1)

(c) During a different part of the journey the car accelerates from 9 m/s to 18 m/s in 6 s.

Use the following equation to calculate the acceleration of the car.

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

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_____

_____

acceleration = _____ m/s^2

(2)

(d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration ☐

resultant force = mass × acceleration ☐

resultant force = mass − acceleration ☐

resultant force = mass ÷ acceleration ☐

(1)

(e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

_____

_____

Resultant force = _____ N

(2)

(f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

_____

_____

_____

Distance = _____ m

(3)

(g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

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You should refer to kinetic energy in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

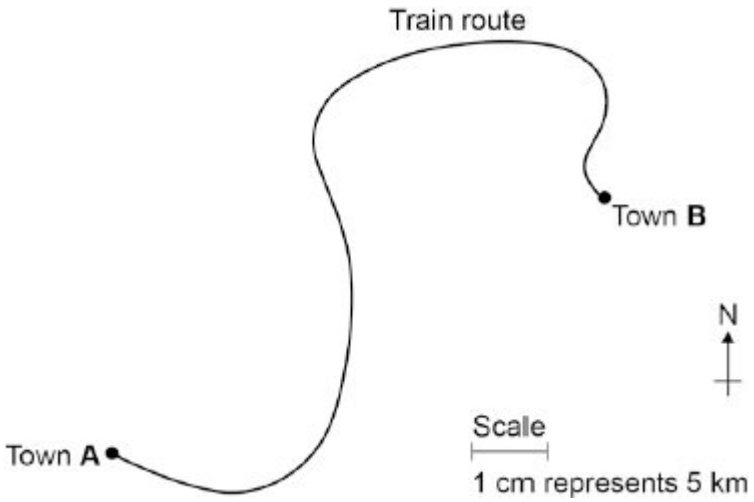
(Total 14 marks)

Q6.

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**.

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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.

_____

_____

_____

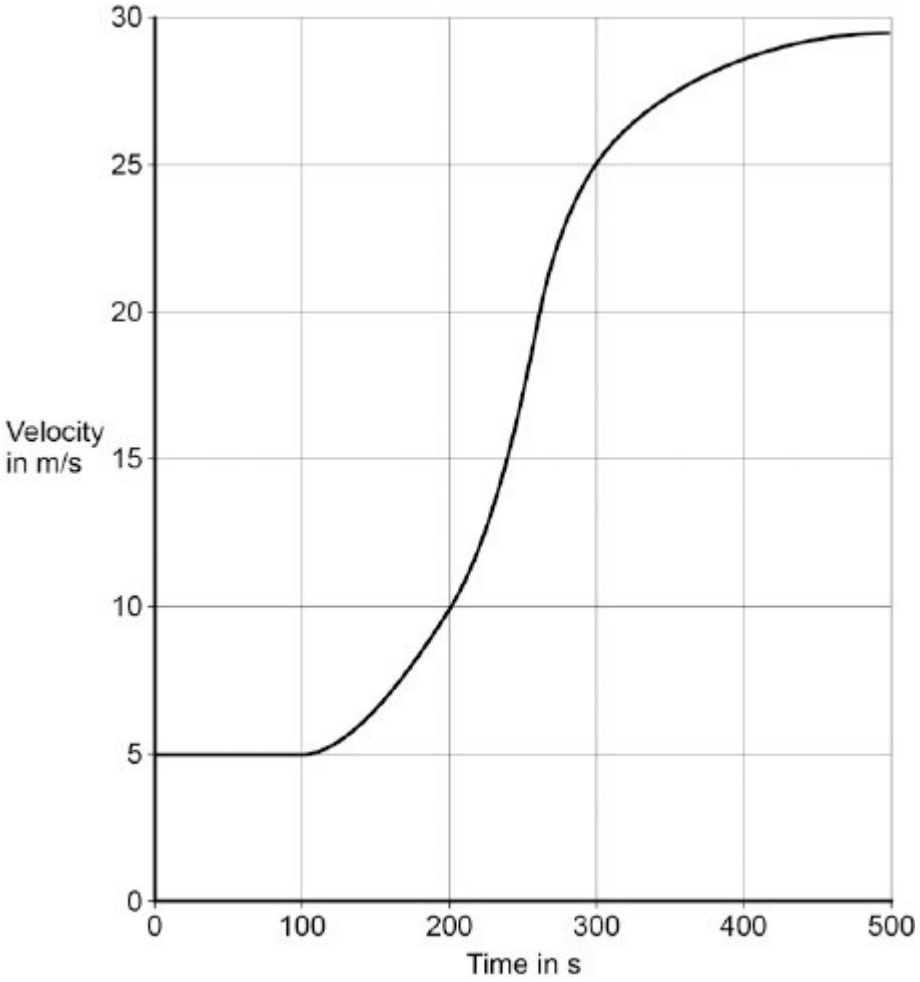
_____

(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

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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)

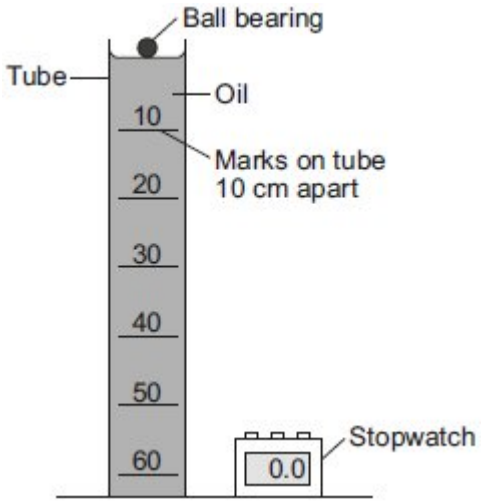
Q7.

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

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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?

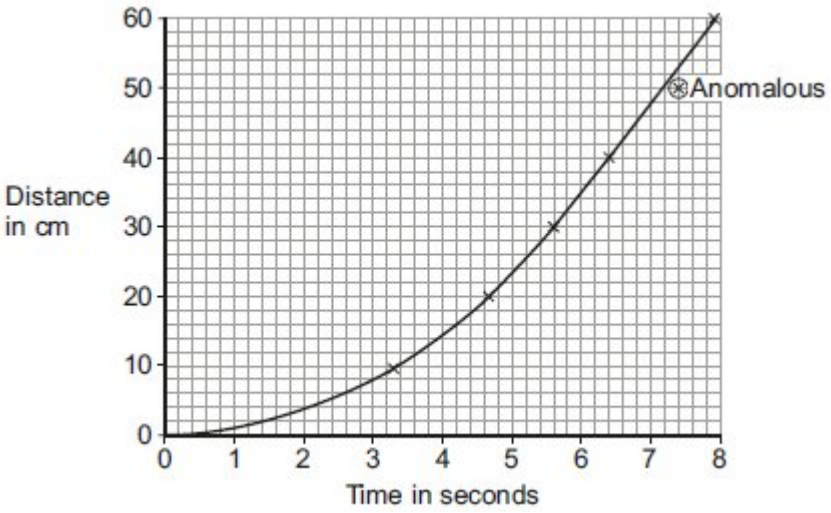
_____

_____

(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)

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(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.

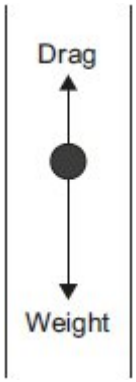
_____

_____

(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.

_____

_____

_____

_____

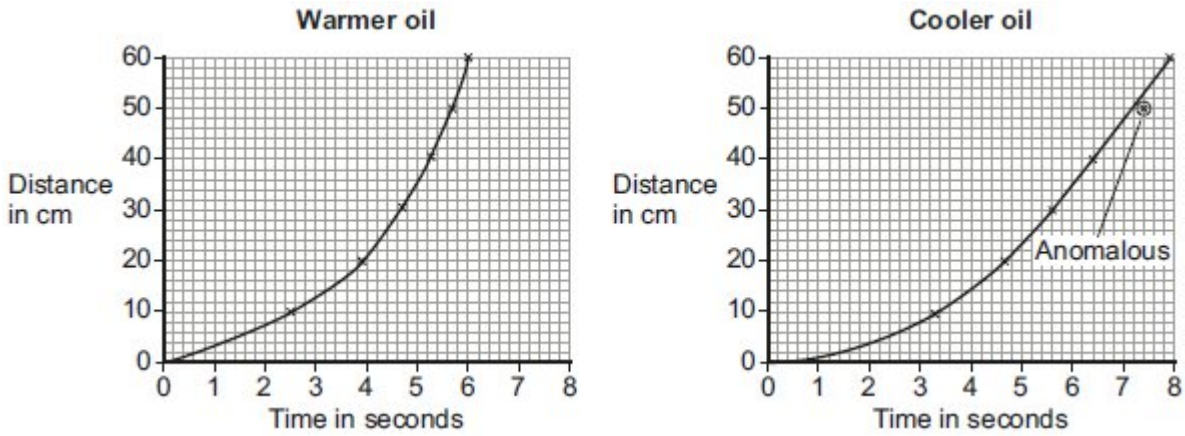
(2)

(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

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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.

_____

_____

_____

_____

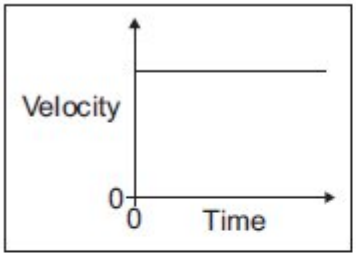
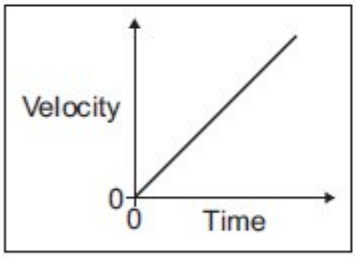
(3)

(Total 9 marks)

Q8.

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

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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 ☐

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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)

Q9.

On 14 October 2012, a skydiver set a world record for the highest free fall from an aircraft.

After falling from the aircraft, he reached a maximum steady velocity of 373 m / s after 632 seconds.

(a) Draw a ring around the correct answer to complete the sentence.

This maximum steady velocity is called the [frictional / initial / terminal] velocity.

(1)

(b) The skydiver wore a chest pack containing monitoring and tracking equipment. The weight of the chest pack was 54 N.

The gravitational field strength is 10 N / kg.

Calculate the mass of the chest pack.

_____

_____

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Mass of chest pack = _____ kg

(2)

(c) During his fall, the skydiver's acceleration was not uniform.

Immediately after leaving the aircraft, the skydiver's acceleration was 10 m / s^2.

(i) Without any calculation, estimate his acceleration a few seconds after leaving the aircraft.

Explain your value of acceleration in terms of forces.

Estimate _____

Explanation _____

_____

_____

_____

_____

_____

(3)

(ii) Without any calculation, estimate his acceleration 632 seconds after leaving the aircraft.

Explain your value of acceleration in terms of forces.

Estimate _____

Explanation _____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q10.

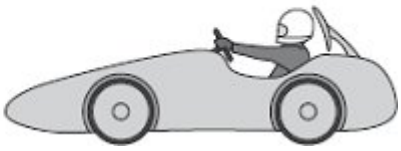
(a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

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First design **X**



Final design **Y**



The go-kart always had the same mass and used the same motor.

The change in shape from the first design (**X**) to the final design (**Y**) will affect the top speed of the go-kart.

Explain why.

_____

_____

_____

_____

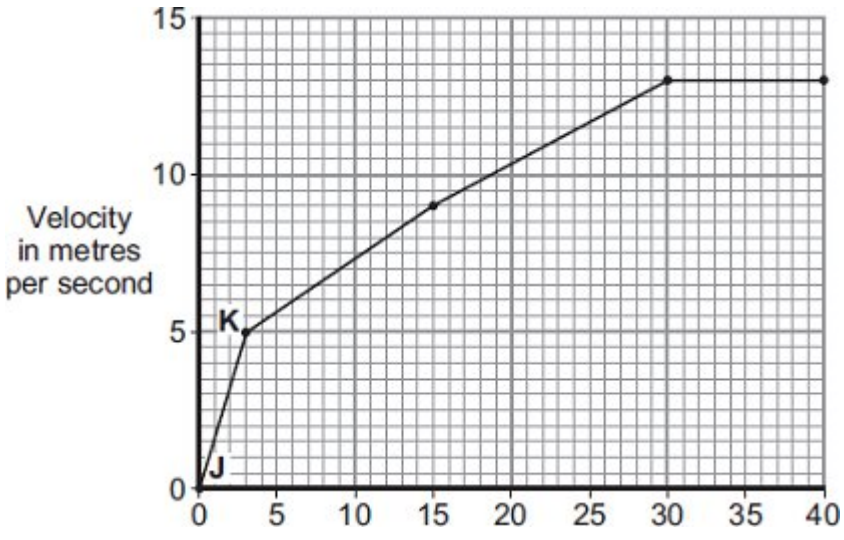
_____

_____

(3)

(b) The final design go-kart, **Y**, is entered into a race.

The graph shows how the velocity of the go-kart changes during the first 40 seconds of the race.



(i) Use the graph to calculate the acceleration of the go-kart between points **J** and **K**.

Give your answer to **two** significant figures.

_____

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_____

_____

Acceleration = _____ m/s^2

(2)

(ii) Use the graph to calculate the distance the go-kart travels between points **J** and **K**.

_____

_____

_____

Distance = _____ m

(2)

(iii) What causes most of the resistive forces acting on the go-kart?

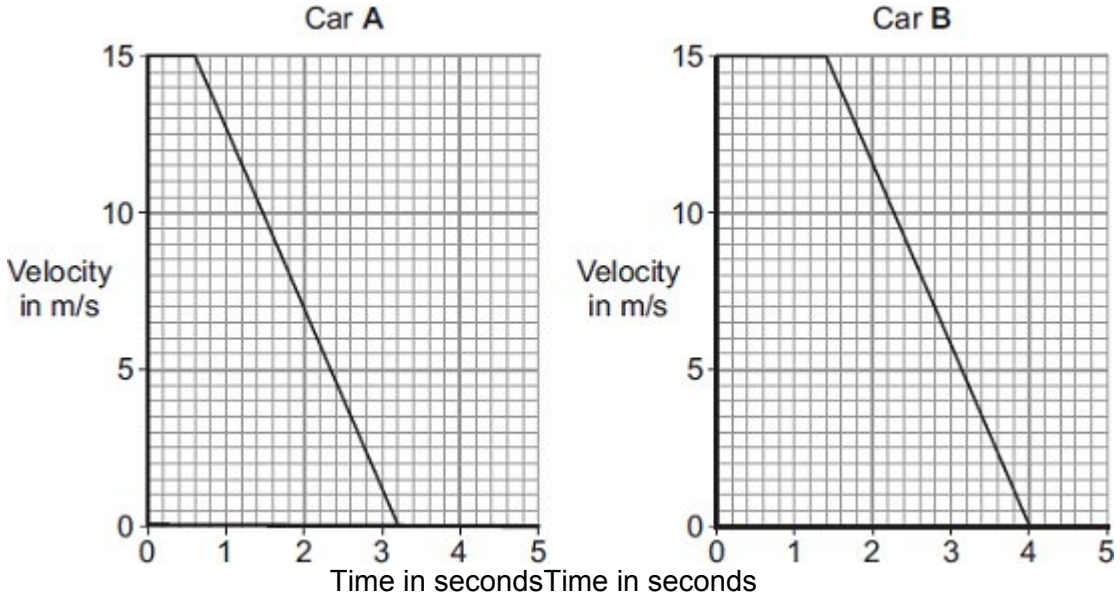
_____

(1)

(Total 8 marks)

Q11.

(a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.



One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

(i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

_____

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_____

(1)

(ii) How do the graphs show that the two cars have the same deceleration?

_____

_____

(1)

(iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

_____

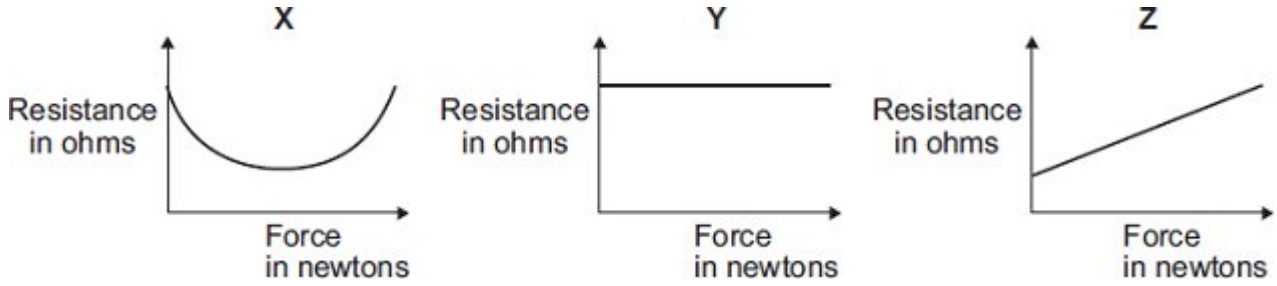
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_____

Additional stopping distance = _____ m

(3)

(b) In a crash-test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y**, and **Z**, change with the force applied to the sensor.



Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

_____

Give a reason for your answer.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q12.

The London Eye is one of the largest observation wheels in the world.

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© Angelo Ferraris/Shutterstock

The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

(a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

_____

_____

_____

(2)

(b) In which direction is the resultant force on each capsule?

_____

(1)

(c) The designers of the London Eye had to consider **three** factors which affect the resultant force described in part (b).

Two factors that increase the resultant force are:

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

_____

_____

(1)

(Total 4 marks)

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Q13.

(a) The diagram shows the forces acting on a parachutist in free fall.



The parachutist has a mass of 75 kg.

Calculate the weight of the parachutist.

gravitational field strength = 10 N/kg

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

_____

_____

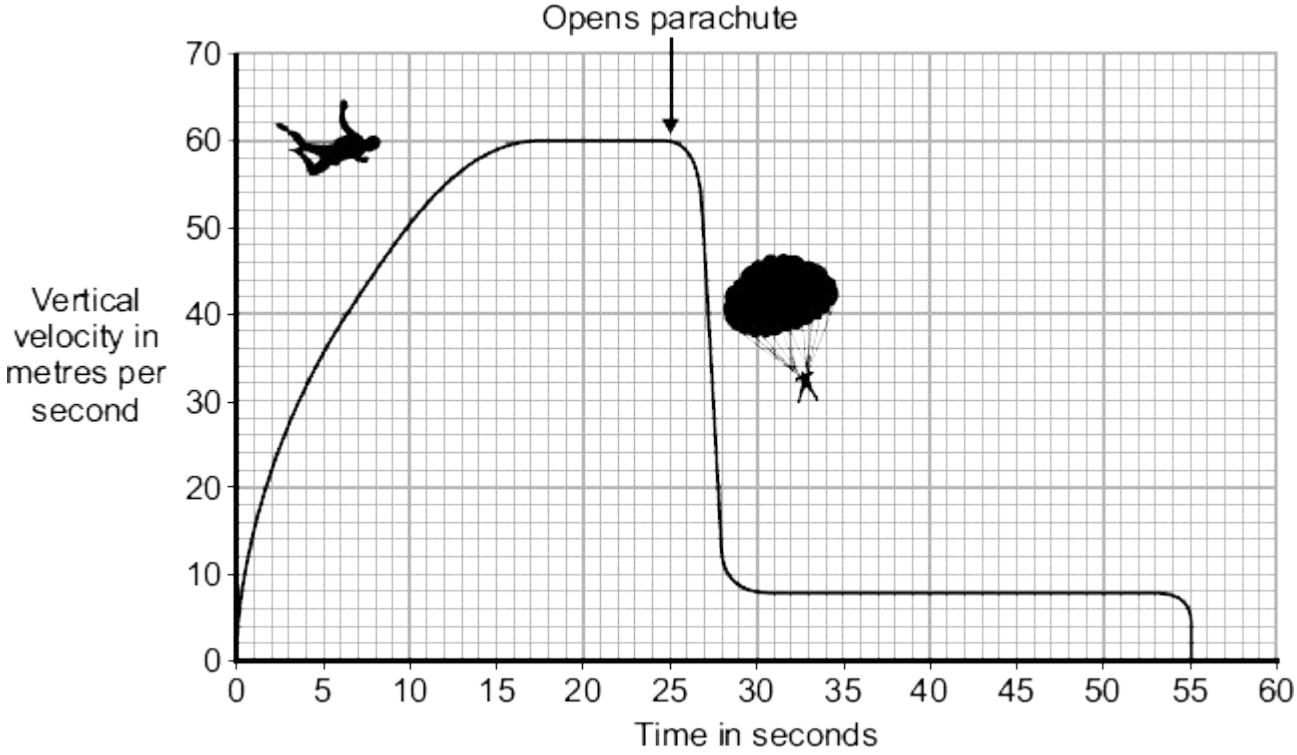
Weight = _____

(3)

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

The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.

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Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

_____

_____

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_____

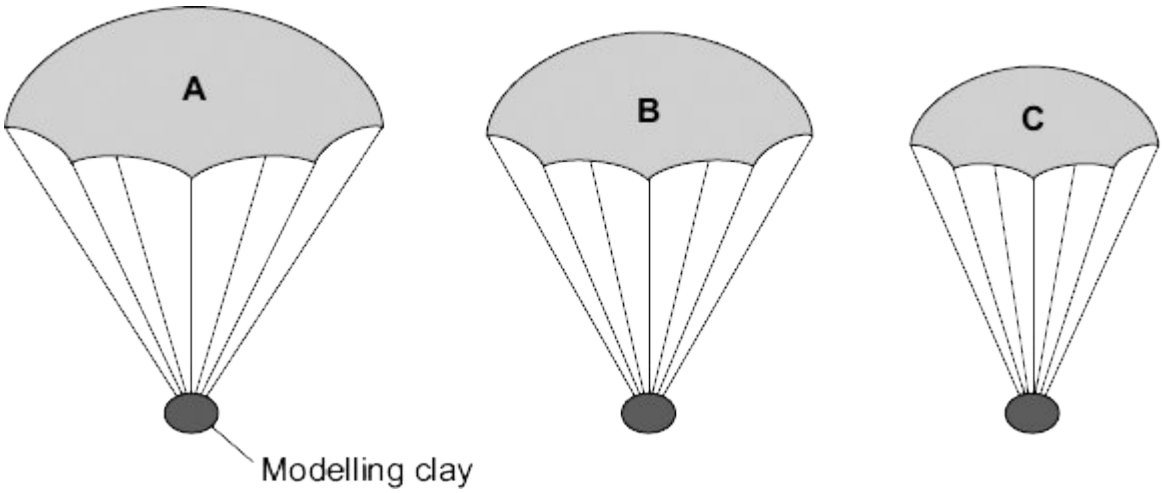
(6)

(c) A student wrote the following hypothesis.

'*The larger the area of a parachute, the slower a parachutist falls.*'

To test this hypothesis the student made three model parachutes, **A**, **B** and **C**, from one large plastic bag. The student dropped each parachute from the same height and timed how long each parachute took to fall to the ground.

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(i) The height that the student dropped the parachute from was a control variable.

Name **one** other control variable in this experiment.

_____

(1)

(ii) Use the student's hypothesis to predict which parachute, **A**, **B** or **C**, will hit the ground first.

Write your answer in the box. ☐

Give a reason for your answer.

_____

_____

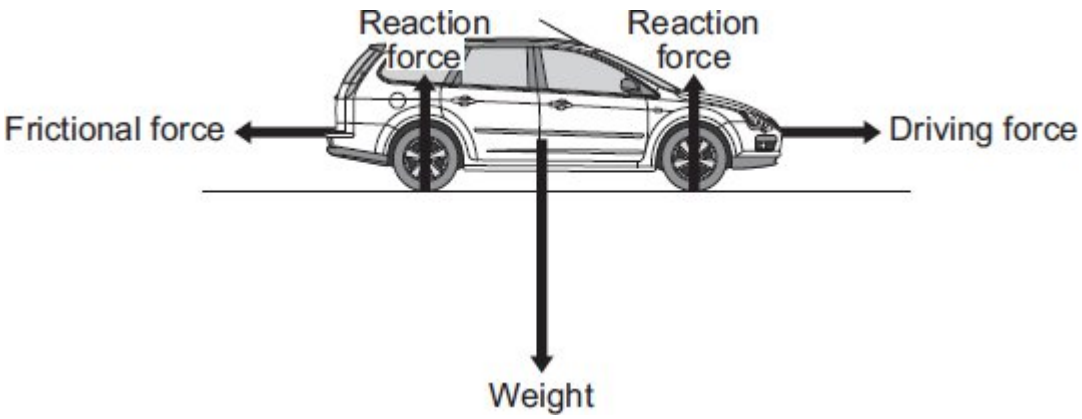
_____

(2)

(Total 12 marks)

Q14.

The diagram shows the forces acting on a car. The car is being driven along a straight, level road at a constant speed of 12 m/s.



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(a) The driver then accelerates the car to 23 m/s in 4 seconds.

Use the equation in the box to calculate the acceleration of the car.

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

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

_____

_____

Acceleration = _____

(3)

(b) Describe how the horizontal forces acting on the car change during the first **two** seconds of the acceleration.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q15.

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.

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

_____

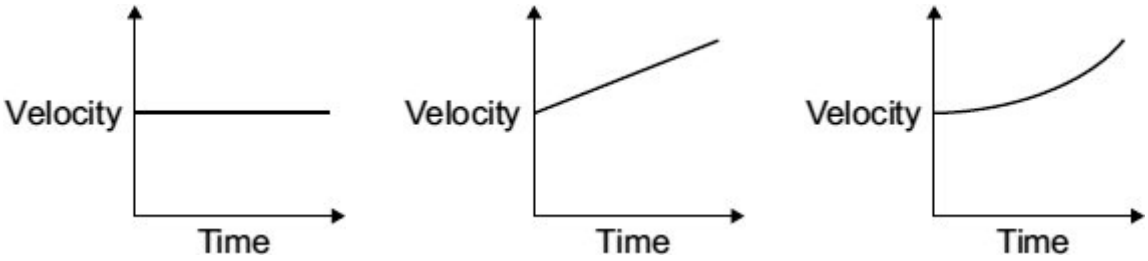
_____

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 ☐

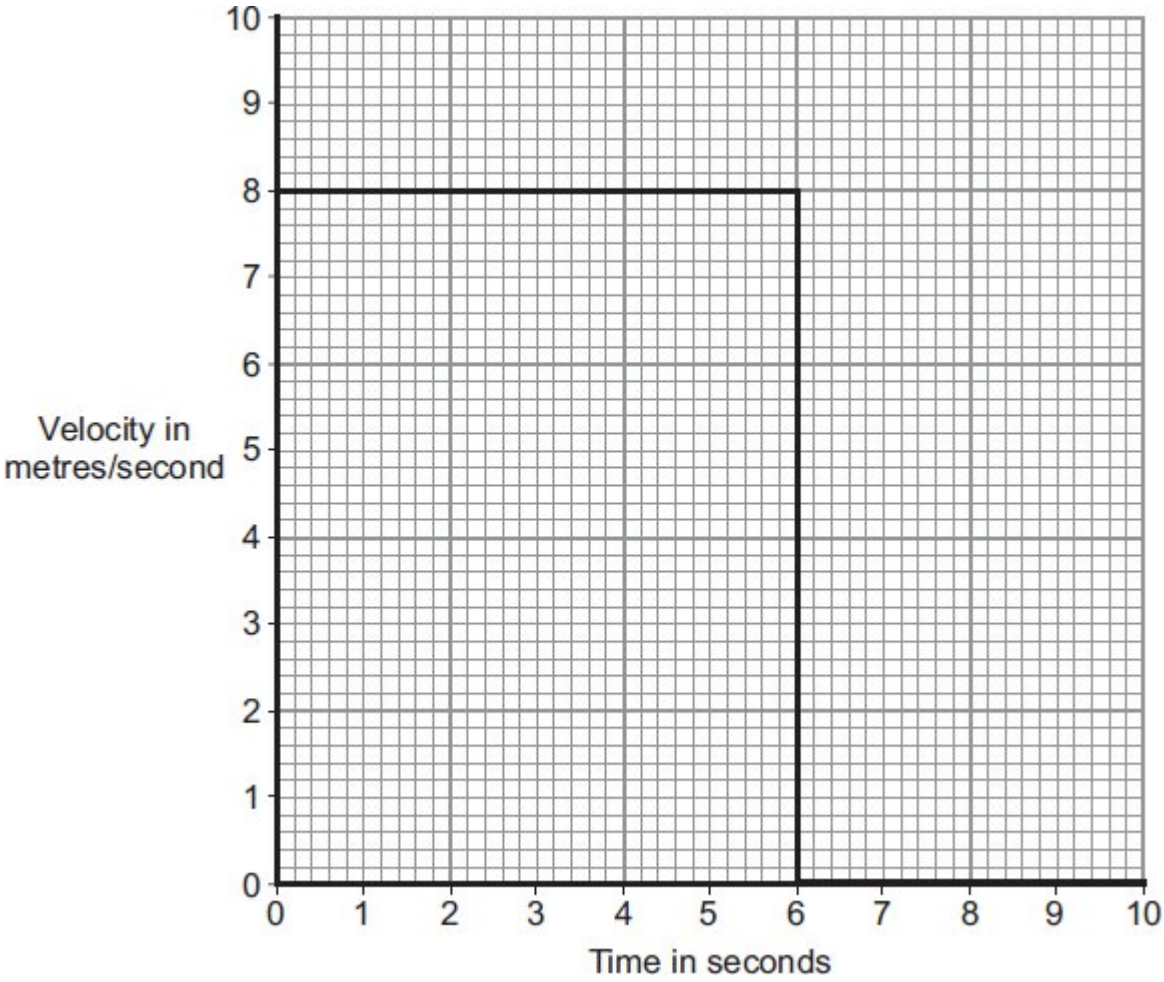
(1)

(Total 4 marks)

Q16.

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

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

Show clearly how you work out your answer.

_____

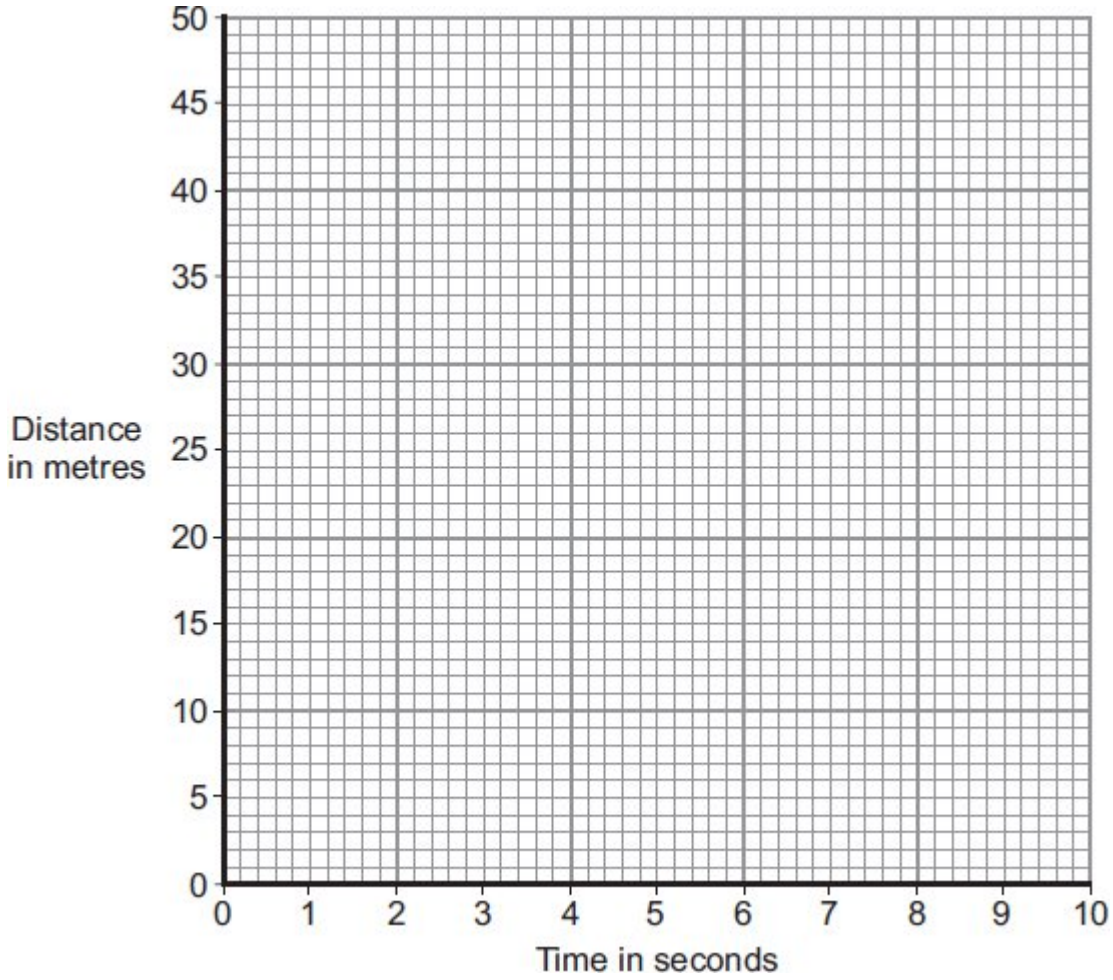
_____

Distance = _____ m

(2)

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

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(2)

(Total 4 marks)

Q17.

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.

_____

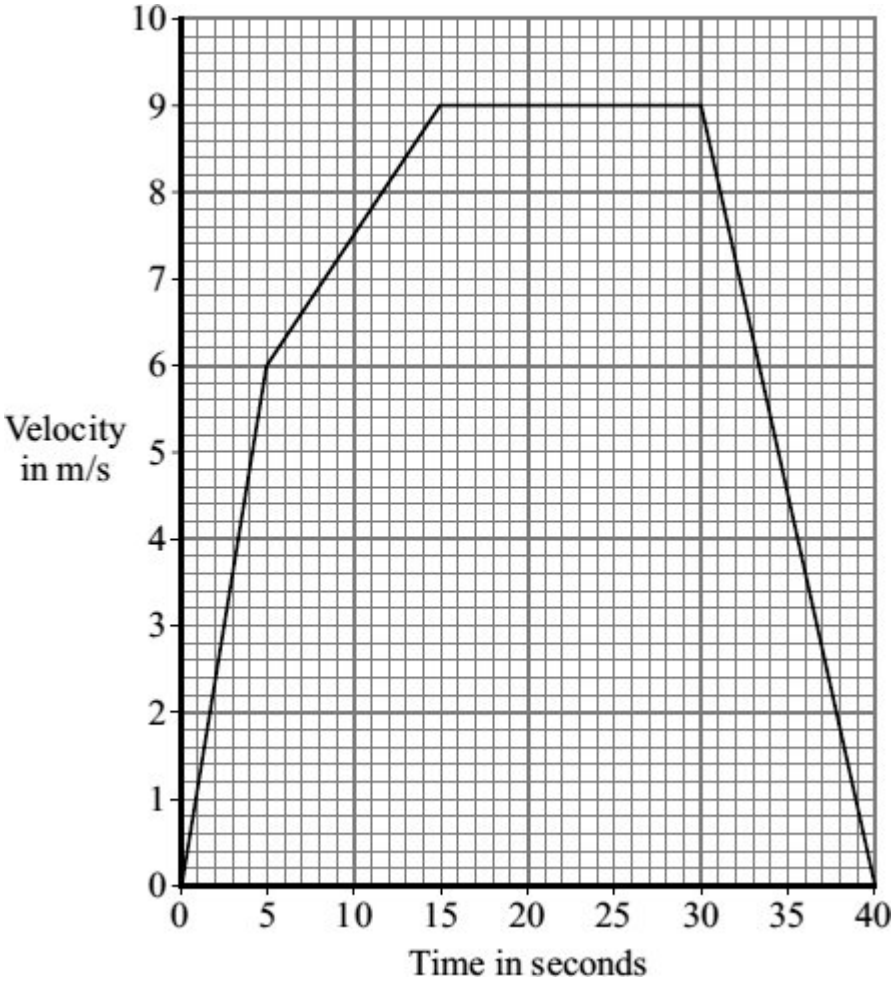
_____

Resultant force = _____

(3)

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

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(i) Complete the following sentence.

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

(1)

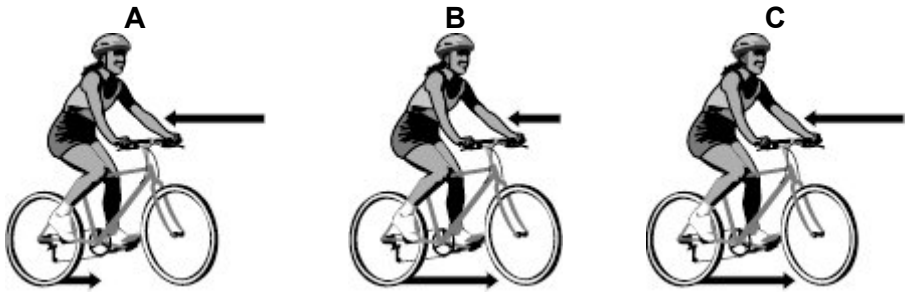
(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

_____

_____

(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.



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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)

Q18.

(a) The total stopping distance of a car has two parts. One part is the distance the car travels during the driver's reaction time. This distance is often called the 'thinking distance'.

What distance is added to the 'thinking distance' to give the total stopping distance?

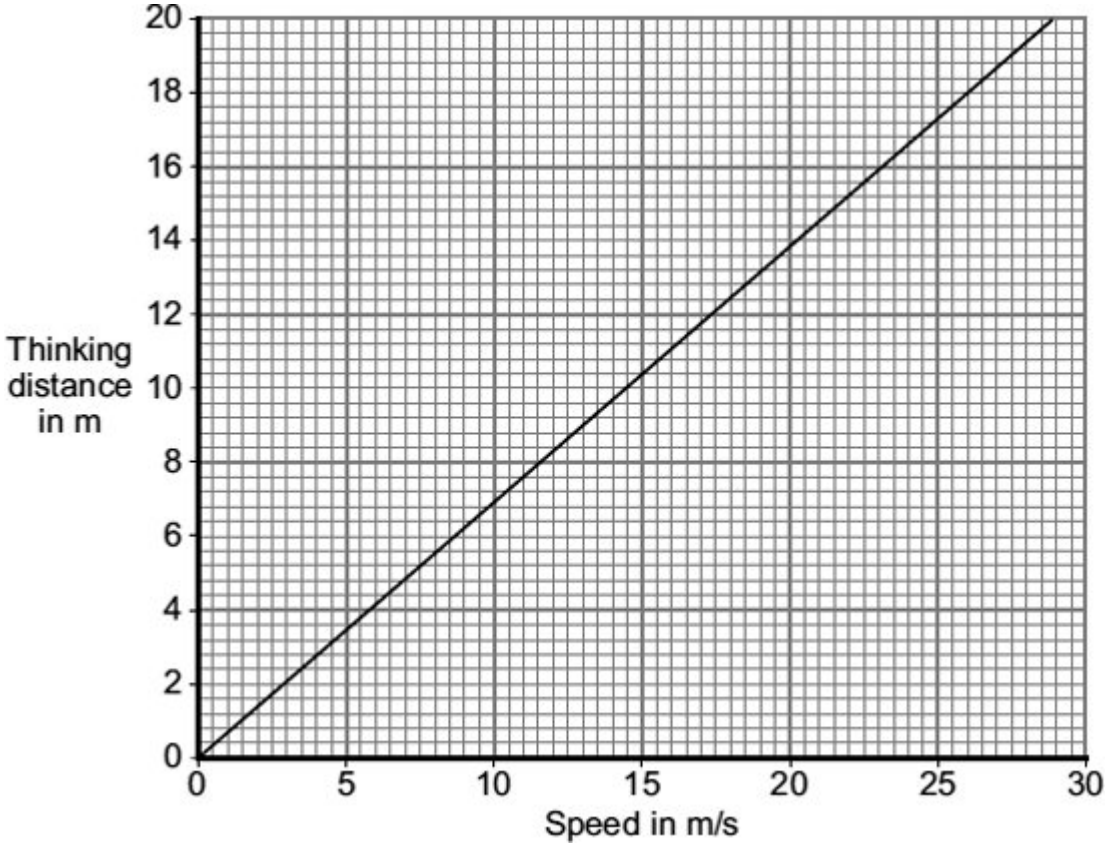
_____

_____

(1)

(b) The graph shows the relationship between the speed of a car and the thinking distance.

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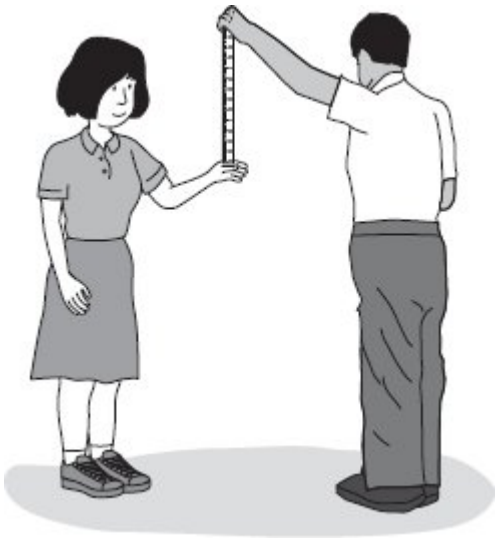
Describe the relationship between speed and thinking distance.

_____

_____

(2)

(c) The diagram shows two students investigating reaction time.



One student holds a 30 cm ruler, then lets go. As soon as the second student sees the ruler fall, she closes her hand, stopping the ruler. The further the ruler falls before being stopped, the slower her reaction time.

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(i) One student always holds the ruler the same distance above the other student's hand.
In this experiment, what type of variable is this?

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

independent variable ☐

dependent variable ☐

control variable ☐

(1)

(ii) Describe how this experiment could be used to find out whether listening to music affects reaction time.

_____

_____

_____

_____

(2)

(d) The following information is written on the label of some cough medicine.

> **WARNING**: Causes drowsiness.
> Do not drive or operate machinery.

How is feeling drowsy (sleepy) likely to affect a driver's reaction time?

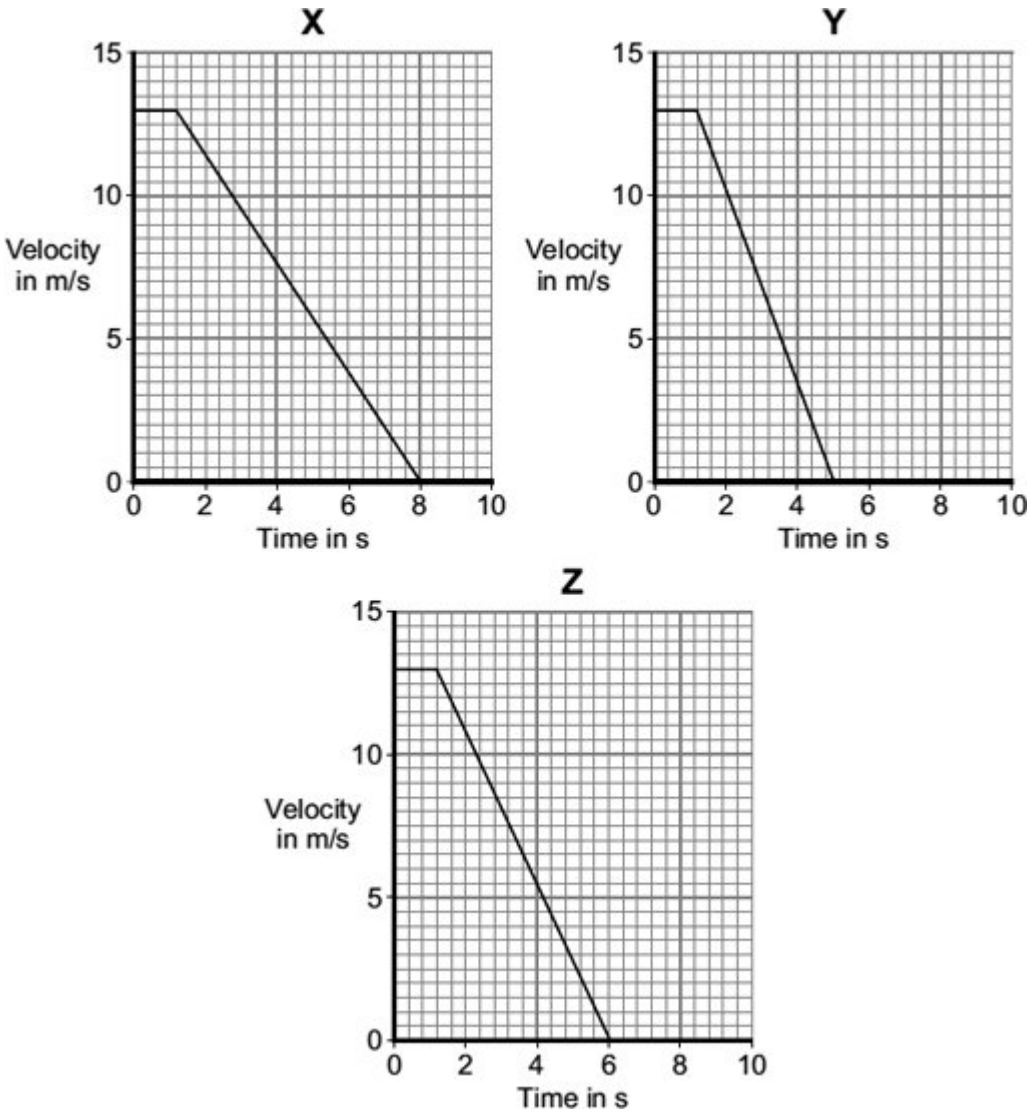
_____

_____

(1)

(e) Three cars, **X**, **Y** and **Z** , are being driven along a straight road towards a set of traffic lights.
The graphs show how the velocity of each car changes once the driver sees that the traffic light has turned to red.

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Which one of the cars, **X**, **Y** or **Z** , stops in the shortest distance?

_____

(1)

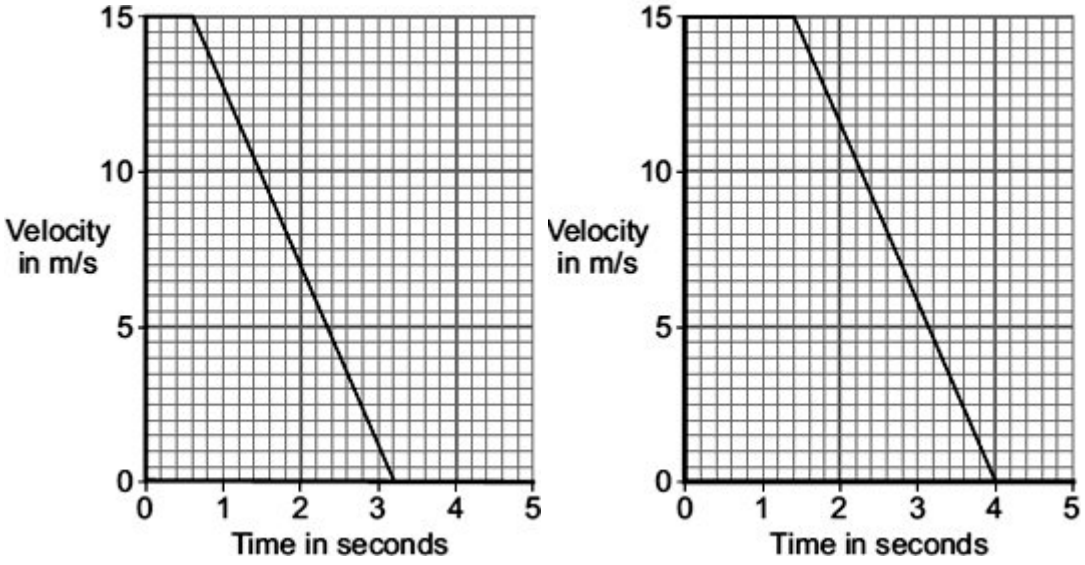
(Total 8 marks)

Q19.

(a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.

Car A **Car B**

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One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

(i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

_____

_____

(1)

(ii) How do the graphs show that the two cars have the same deceleration?

_____

_____

(1)

(iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

_____

_____

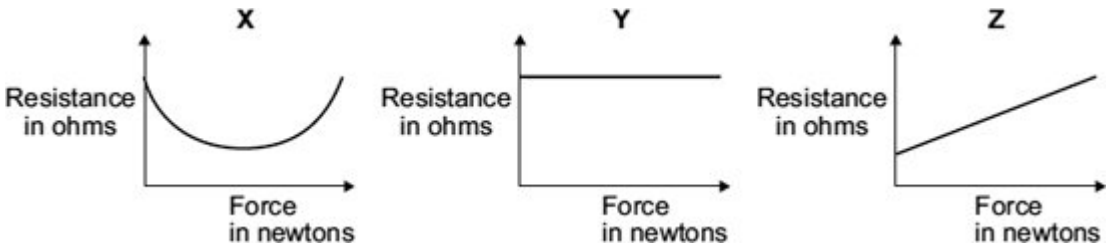
_____

Additional stopping distance = _____ m

(3)

(b) In a crash test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y** and **Z**, change with the force applied to the sensor.

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Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

_____

Give a reason for your answer.

_____

_____

_____

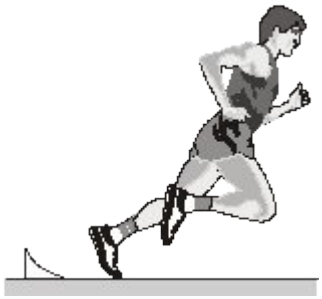
_____

(2)

(Total 7 marks)

Q20.

(a) The diagram shows an athlete at the start of a race. The race is along a straight track.



In the first 2 seconds, the athlete accelerates constantly and reaches a speed of 9 m/s.

(i) Calculate the acceleration of the athlete.

Show clearly how you work out your answer.

_____

_____

_____

Acceleration = _____

(2)

(ii) Which **one** of the following is the unit for acceleration?

Draw a ring around your answer.

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J/s **m/s** **m/s²** **Nm**

(1)

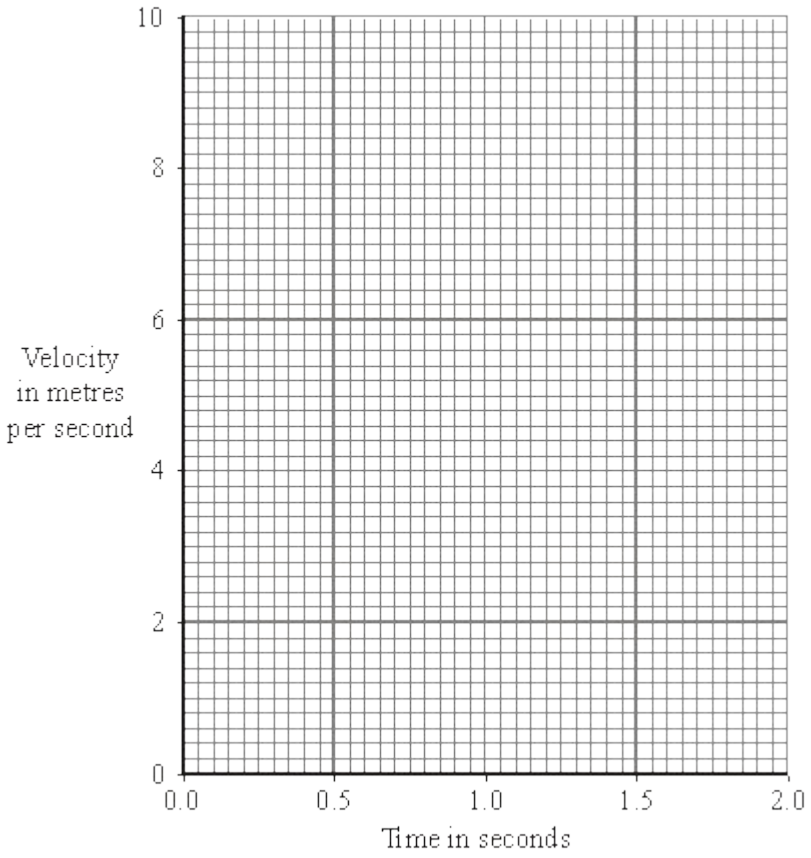
(iii) Complete the following sentence.

The velocity of the athlete is the _____ of

the athlete in a given direction.

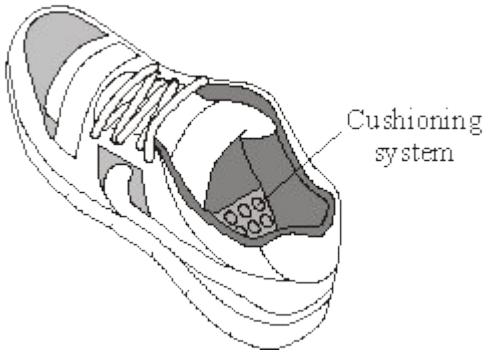
(1)

(iv) Complete the graph to show how the velocity of the athlete changes during the first 2 seconds of the race.



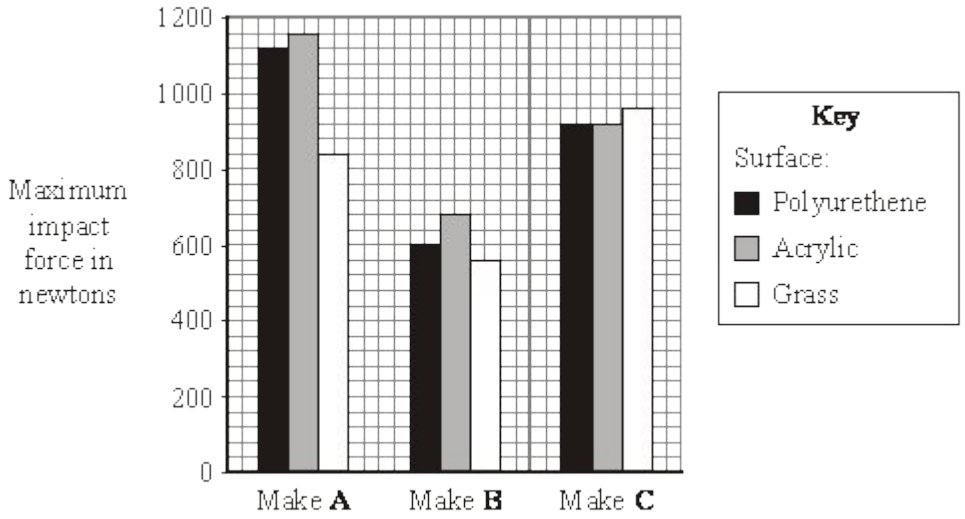
(2)

(b) Many running shoes have a cushioning system. This reduces the impact force on the athlete as the heel of the running shoe hits the ground.



The bar chart shows the maximum impact force for three different makes of running shoe used on three different types of surface.

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(i) Which **one** of the three makes of running shoe, **A**, **B** or **C**, has the best cushioning system?

_____

Explain the reason for your answer.

_____

_____

_____

_____

(3)

(ii) The data needed to draw the bar chart was obtained using a robotic athlete fitted with electronic sensors.

Why is this data likely to be more reliable than data obtained using human athletes?

_____

_____

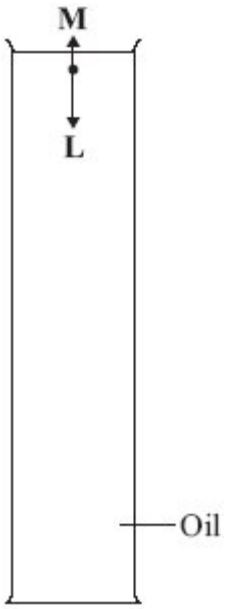
(1)

(Total 10 marks)

Q21.

(a) The diagram shows a steel ball-bearing falling through a tube of oil.
The forces, **L** and **M**, act on the ball-bearing.

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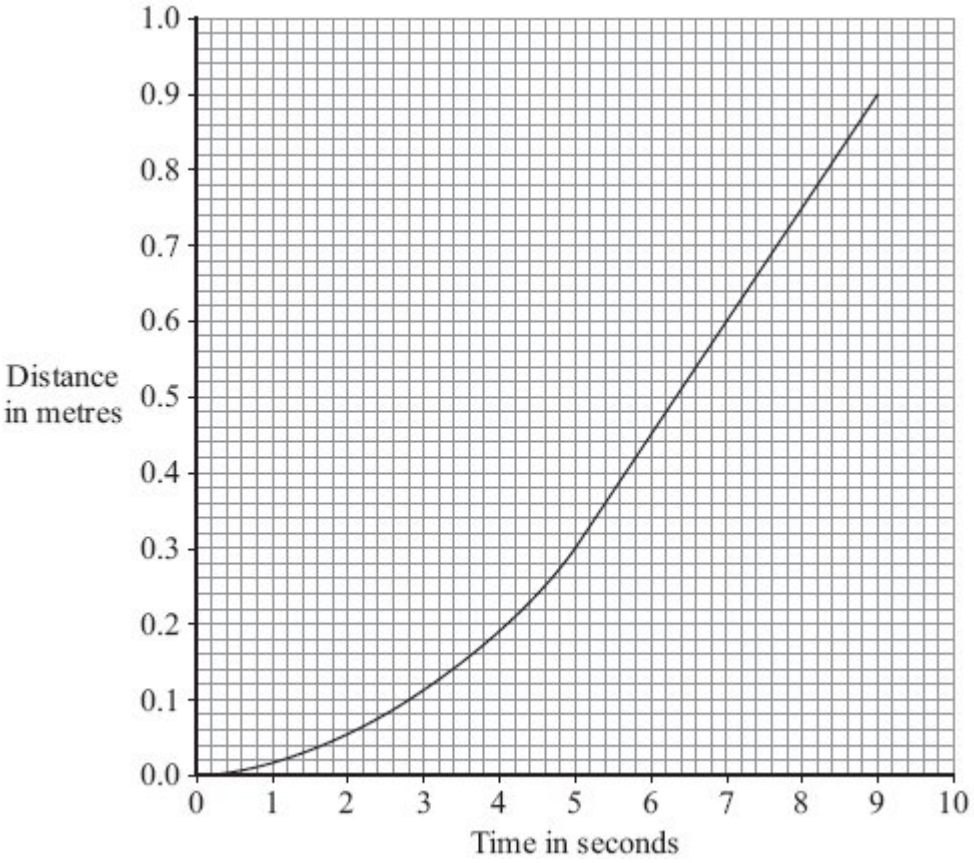


What causes force **L**?

_____

(1)

(b) The distance – time graph represents the motion of the ball-bearing as it falls through the oil.



(i) Explain, in terms of the forces, **L** and **M**, why the ball-bearing accelerates at first but then falls at constant speed.

_____

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_____

_____

_____

_____

_____

(3)

(ii) What name is given to the constant speed reached by the falling ball-bearing?

_____

(1)

(iii) Calculate the constant speed reached by the ball-bearing.

Show clearly how you use the graph to work out your answer.

_____

_____

_____

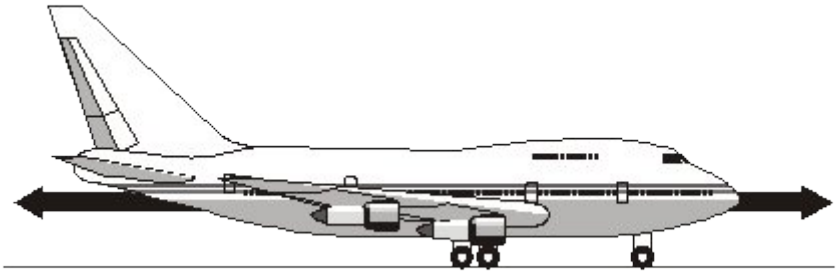
Speed = _____ m/s

(2)

(Total 7 marks)

Q22.

(a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The *resultant force* on the aircraft is zero.



(i) What is meant by the term *resultant force*?

_____

_____

(1)

(ii) Describe the movement of the aircraft when the resultant force is zero.

_____

_____

(1)

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(b) The aircraft has a take-off mass of 320 000 kg. Each of the 4 engines can produce a maximum force of 240 kN.

Calculate the maximum acceleration of the aircraft.

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

_____

_____

_____

Acceleration = _____

(3)

(c) As the aircraft moves along the runway to take off, its acceleration decreases even though the force from the engines is constant.

Explain why.

_____

_____

_____

_____

(2)

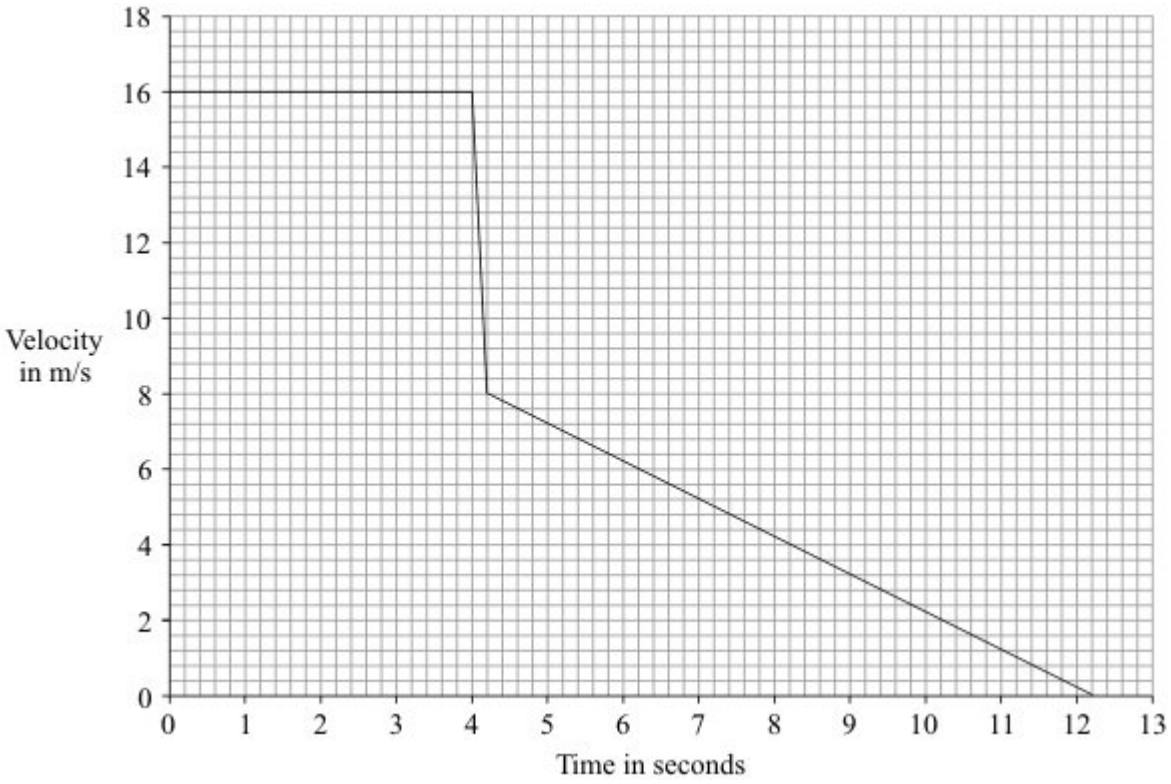
(Total 7 marks)

Q23.

In an experiment at an accident research laboratory, a car driven by remote control was crashed into the back of an identical stationary car. On impact the two cars joined together and moved in a straight line.

(a) The graph shows how the velocity of the remote-controlled car changed during the experiment.

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(i) How is the *velocity* of a car different from the speed of a car?

_____

(1)

(ii) Use the graph to calculate the distance travelled by the remote-controlled car before the collision.

Show clearly how you work out your answer.

_____

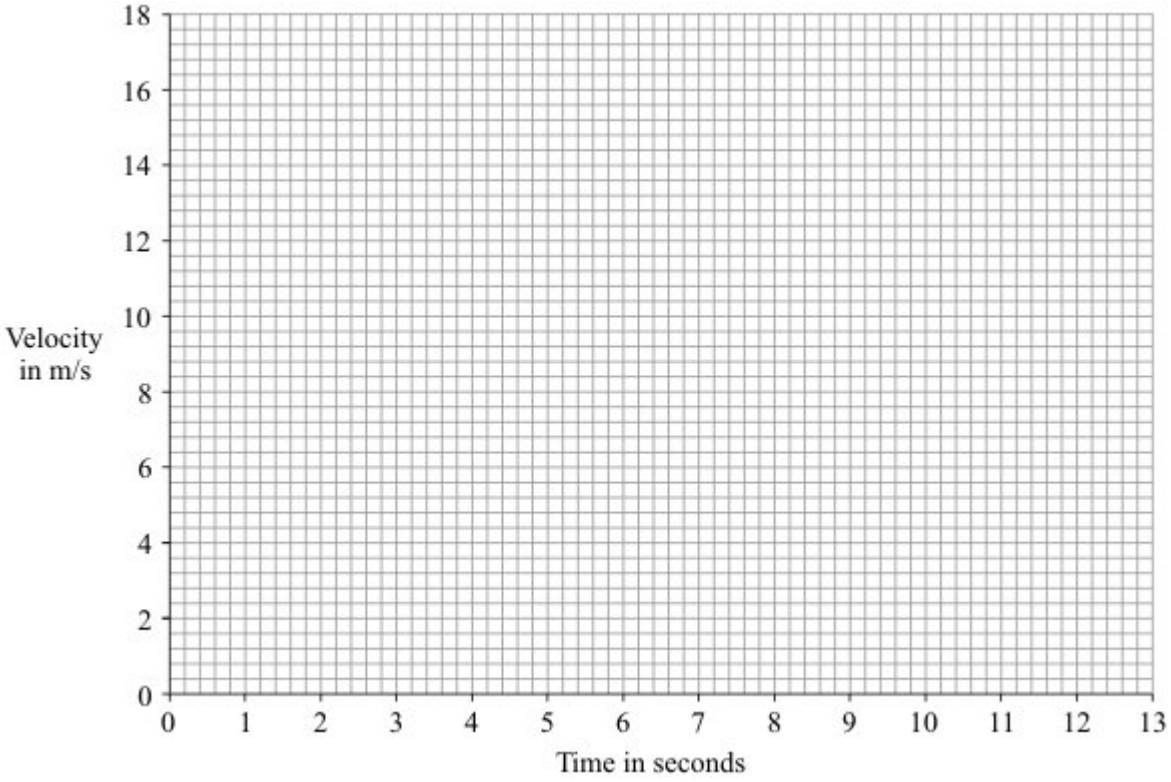
_____

Distance = _____ m

(2)

(iii) Draw, on the grid below, a graph to show how the velocity of the second car changed during the experiment.

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(2)

(iv) The total momentum of the two cars was not conserved.

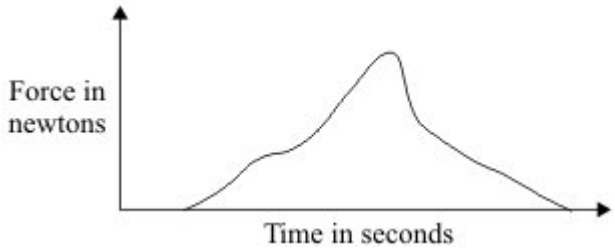
What does this statement mean?

_____

_____

(1)

(b) The graph line shows how the force from a seat belt on a car driver changes during a collision.



Scientists at the accident research laboratory want to develop a seat belt that produces a constant force throughout a collision.

Use the idea of momentum to explain why this type of seat belt would be better for a car driver.

_____

_____

_____

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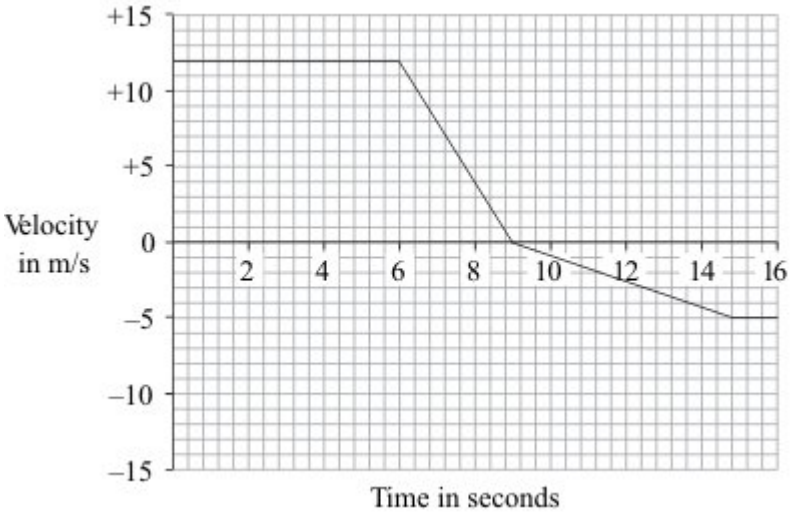
_____

(2)

(Total 8 marks)

Q24.

A car is driven along a straight road. The graph shows how the velocity of the car changes during part of the journey.



(a) Use the graph to calculate the deceleration of the car between 6 and 9 seconds.

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

_____

_____

_____

Deceleration = _____

(3)

(b) At what time did the car change direction?

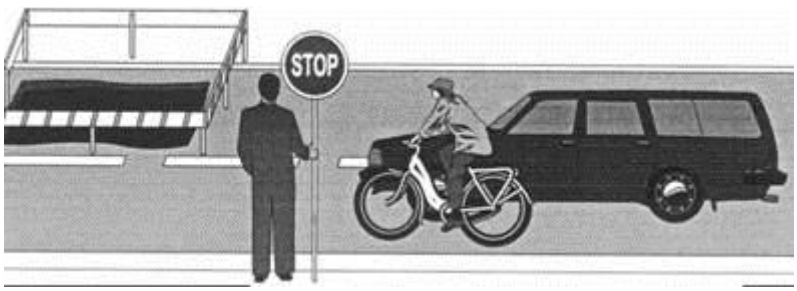
_____ seconds

(1)

(Total 4 marks)

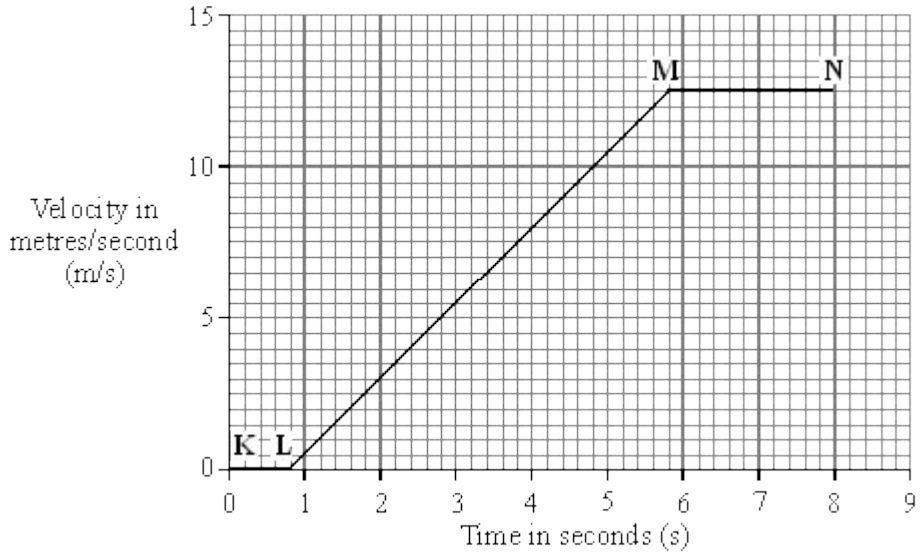
Q25.

A car and a bicycle are travelling along a straight road. They have stopped at road works.



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The graph shows how the velocity of the car changes after the sign is changed to GO.



(a) Between which two points on the graph is the car moving at constant velocity?

_____

(1)

(b) Between which two points on the graph is the car accelerating?

_____

(1)

(c) Between the sign changing to GO and the car starting to move, there is a time delay. This is called the reaction time.

(i) What is the reaction time of the car driver?

Reaction time = _____ seconds

(1)

(ii) Which **one** of the following could increase the reaction time of a car driver? Tick the box next to your choice.

Drinking alcohol ☐

Wet roads ☐

Worn car brakes ☐

(1)

(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2)

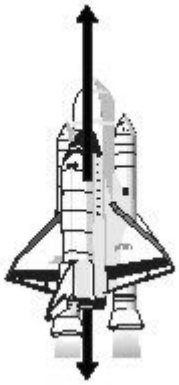
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(Total 6 marks)

Q26.

(a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.

Thrust force



Weight of shuttle, fuel tanks and booster rockets plus air resistance

(i) Describe the upward motion of the space shuttle one second after launch.

_____

(1)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

_____

(1)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

_____

(1)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

_____

_____

average acceleration = _____ m/s^2

(2)

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(iii) How is the velocity of an object different from the speed of an object?

_____

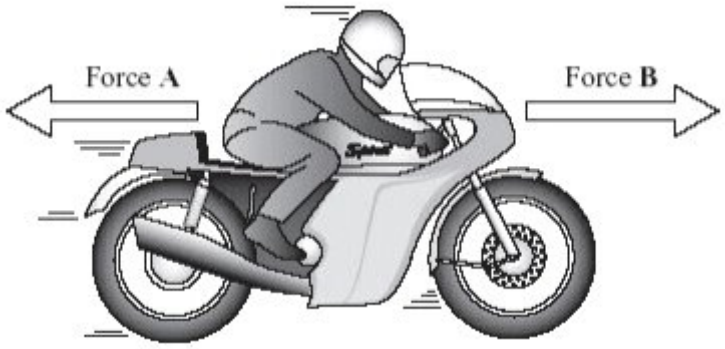
_____

(1)

(Total 6 marks)

Q27.

(a) The diagram shows the horizontal forces that act on a **moving** motorbike.



(i) Describe the movement of the motorbike when force **A** equals force **B**.

_____

_____

(2)

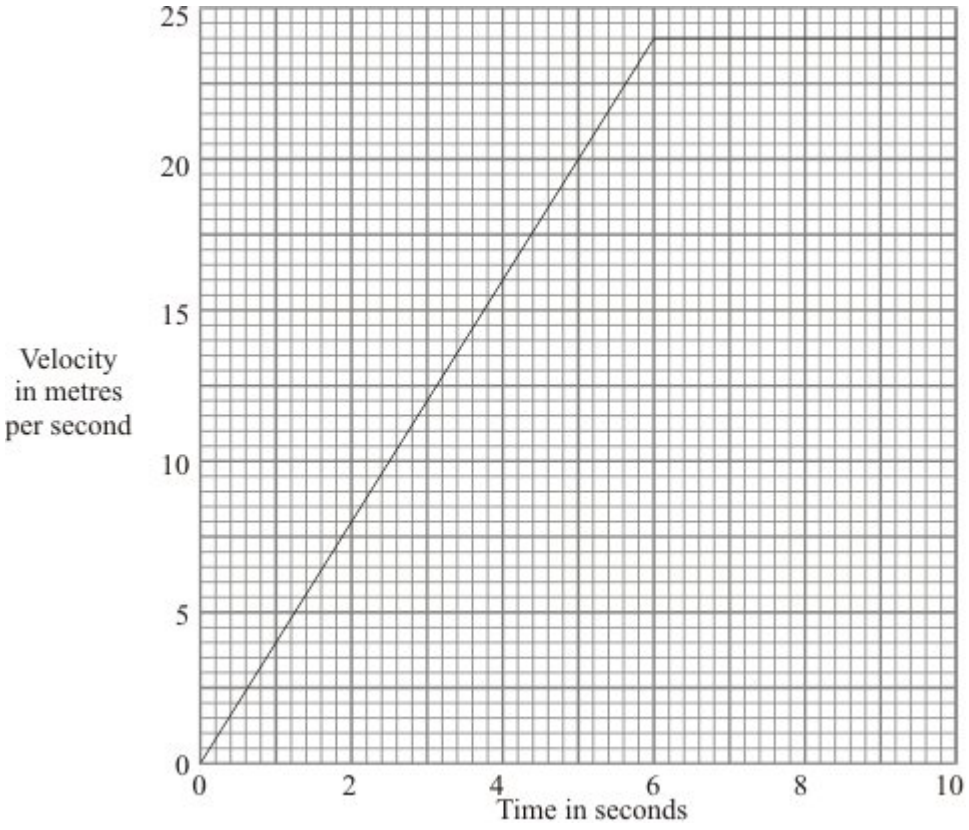
(ii) What happens to the speed of the motorbike if force **B** becomes smaller than force **A**?

_____

(1)

(b) The graph shows how the velocity of a motorbike changes when it is travelling along a straight road.

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(i) What was the change in velocity of the motorbike in the first 5 seconds?

_____

(1)

(ii) Write down the equation which links acceleration, change in velocity and time taken.

_____

(1)

(iii) Calculate the acceleration of the motorbike during the first 5 seconds. Show clearly how you work out your answer and give the unit.

_____

_____

Acceleration = _____

(3)

(c) A car is travelling on an icy road.

Describe and explain what might happen to the car when the brakes are applied.

_____

_____

_____

_____

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(2)

(d) Name **three** factors, other than weather conditions, which would increase the overall stopping distance of a vehicle.

1. _____

_____

2. _____

_____

3. _____

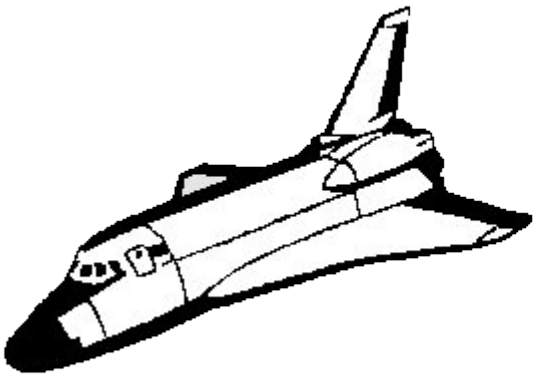
_____

(3)

(Total 13 marks)

Q28.

The diagram shows an orbiter, the reusable part of a space shuttle. The data refers to a typical flight.



Orbiter data	
Mass	78 000 kg
Orbital speed	7.5 km/s
Orbital altitude	200 km
Landing speed	100 m/s
Flight time	7 days

(a) (i) What name is given to the force which keeps the orbiter in orbit around the Earth?

_____

(1)

(ii) Use the following equation to calculate the kinetic energy, in joules, of the orbiter while it is in orbit.

$$\text{kinetic energy} = \tfrac{1}{2}\, mv^2$$

_____

_____

Kinetic energy = _____ joules

(2)

(iii) What happens to most of this kinetic energy as the orbiter re-enters the Earth's atmosphere?

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_____

_____

(1)

(b) After touchdown the orbiter decelerates uniformly coming to a halt in 50 s.

(i) Give the equation that links acceleration, time and velocity.

_____

(1)

(ii) Calculate the deceleration of the orbiter. Show clearly how you work out your answer and give the unit.

_____

_____

Deceleration = _____

(2)

(c) (i) Give the equation that links acceleration, force and mass.

_____

(1)

(ii) Calculate, in newtons, the force needed to bring the orbiter to a halt. Show clearly how you work out your answer.

_____

_____

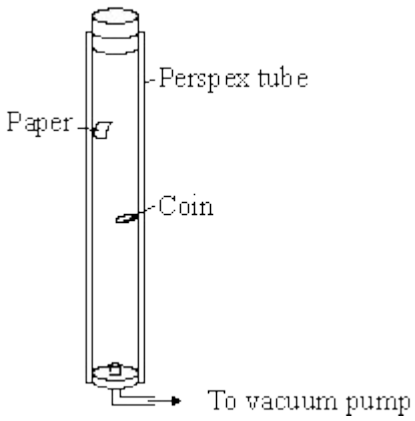
Force = _____ newtons

(1)

(Total 9 marks)

Q29.

The apparatus shown is used to compare the motion of a coin with the motion of a piece of paper as they both fall.



(a) When the tube is filled with air the coin falls faster than the piece of paper. Why?

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_____

_____

(1)

(b) The air in the tube is removed by the vacuum pump. The tube is turned upside down.
State **two** ways in which the motion of the coin and piece of paper will change compared to when there was air in the tube.

1. _____

_____

_____

2. _____

_____

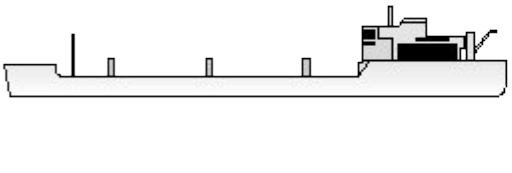
_____

(2)

(Total 3 marks)

Q30.

The table contains typical data for an oil tanker.



Mass	56 000 000 kg
Cruising speed	12 m/s
Deceleration force	392 000 N
Stopping distance	10 000 m

(i) Write down the equation which links acceleration, force and mass.

_____

(1)

(ii) Calculate the deceleration of the oil tanker. Show clearly how you work out your answer.

_____

_____

_____

Deceleration = _____ m/s^2

(2)

(Total 3 marks)

Q31.

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The manufacturer of a family car gave the following information.

Mass of car 950 kg

The car will accelerate from 0 to 33 m/s in 11 seconds.

(a) Calculate the acceleration of the car during the 11 seconds.

_____

_____

_____

(2)

(b) Calculate the force needed to produce this acceleration.

_____

_____

_____

(2)

(c) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

_____

_____

_____

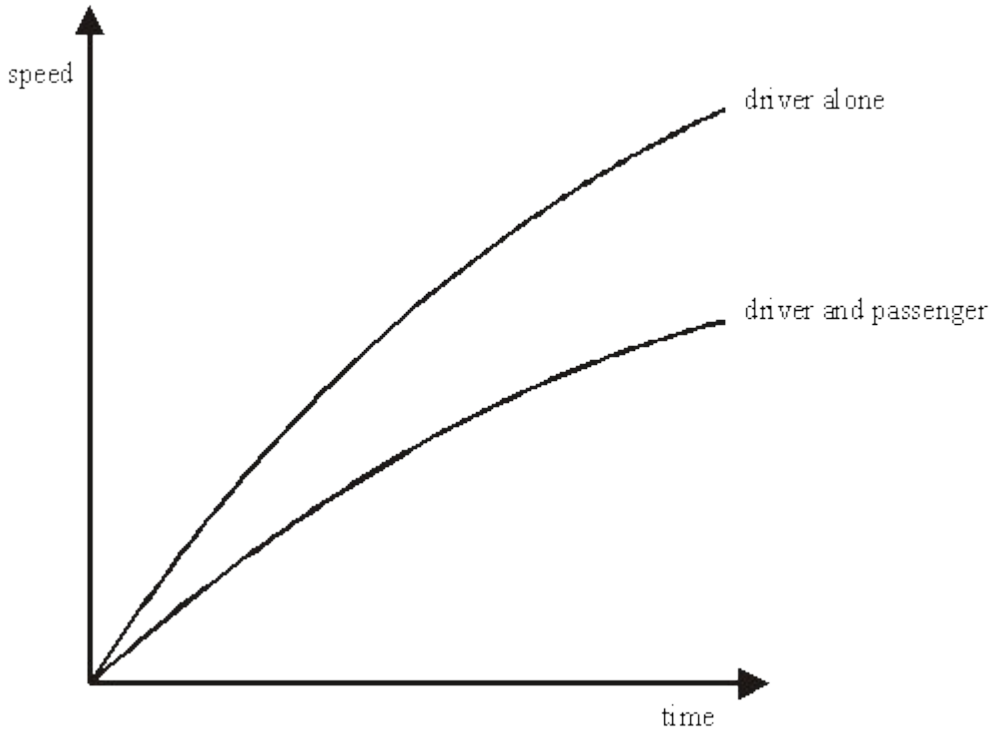
(3)

(Total 7 marks)

Q32.

(a) When a car is driven efficiently the engine gives a constant forward pull on the car as the car accelerates to its maximum speed. During this time frictional forces and air resistance oppose the forward motion of the car. The sketch graphs below show how the car's speed increases when only the driver is in the car, and when the driver has a passenger in the car.

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(i) How does the acceleration of the car change with time?

_____

_____

(1)

(ii) What conclusion can be made about the resultant (net) forward force on the car as its speed increases?

_____

_____

(1)

(ii) On the graph, draw a line to show how you would expect the car's speed to vary if it carried three passengers.

(1)

(b) The manufacturer of a family car gave the following information.

Mass of car 950g

The car will accelerate from 0 to 33 m/s in 11 seconds.

(i) Calculate the acceleration of the car during the 11 seconds.

_____

_____

_____

Answer _____

(2)

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(ii) Calculate the force needed to produce this acceleration.

_____

_____

_____

Answer _____ N

(2)

(iii) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

_____

_____

(2)

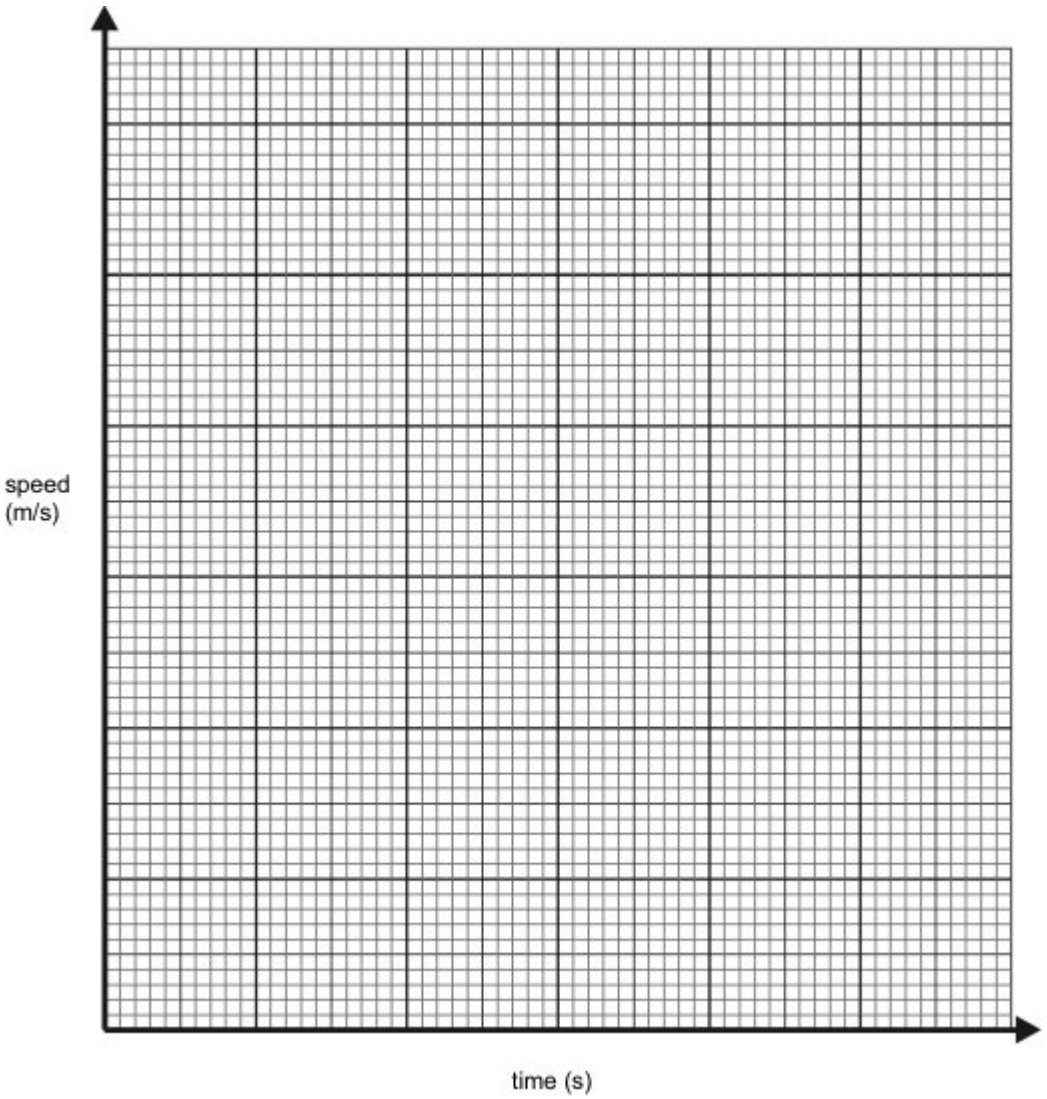
(Total 9 marks)

Q33.

A driver is driving along a road at 30 m/s. The driver suddenly sees a large truck parked across the road and reacts to the situation by applying the brakes so that a constant braking force stops the car. The reaction time of the driver is 0.67 seconds, it then takes another 5 seconds for the brakes to bring the car to rest.

(a) Using the data above, draw a speed-time graph to show the speed of the car from the instant the truck was seen by the driver until the car stopped.

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(5)

(b) Calculate the acceleration of the car whilst the brakes are applied.

Answer = _____ m/s^2

(3)

(c) The mass of the car is 1500 kg. Calculate the braking force applied to the car.

Answer = _____ N

(3)

(d) The diagrams below show what would happen to a driver in a car crash.

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(i) Explain why the driver tends to be thrown towards the windscreen.

_____

_____

_____

_____

_____

_____

(ii) The car was travelling at 30 m/s immediately before the crash. Calculate the energy which has to be dissipated as the front of the car crumples.

_____

_____

_____

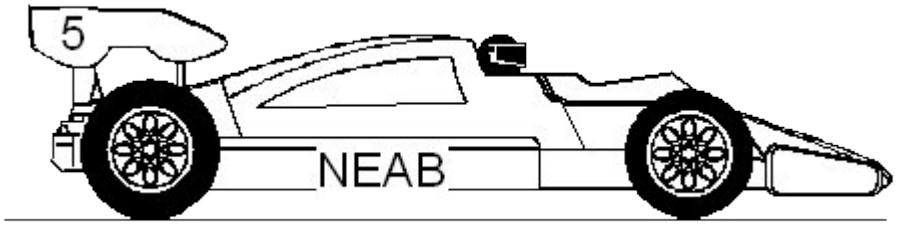
_____

(8)

(Total 17 marks)

Q34.

A racing driver is driving his car along a **straight** and **level** road as shown in the diagram below.



(a) The driver pushes the accelerator pedal as far down as possible. The car does not accelerate above a certain maximum speed. Explain the reasons for this in terms of the forces acting on the car.

_____

_____

_____

_____

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_____

_____

(4)

(b) The racing car has a mass of 1250 kg. When the brake pedal is pushed down a constant braking force of 10 000 N is exerted on the car.

(i) Calculate the acceleration of the car.

_____

_____

_____

_____

_____

(ii) Calculate the kinetic energy of the car when it is travelling at a speed of 48 m/s.

_____

_____

_____

_____

(iii) When the brakes are applied with a constant force of 10 000 N the car travels a distance of 144 m before it stops. Calculate the work done in stopping the car.

_____

_____

_____

_____

_____

_____

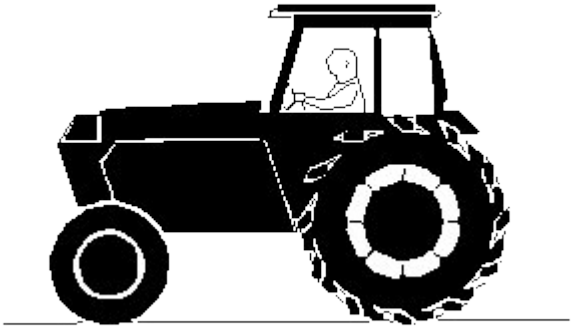
(12)

(Total 16 marks)

Q35.

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

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(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?

_____

_____

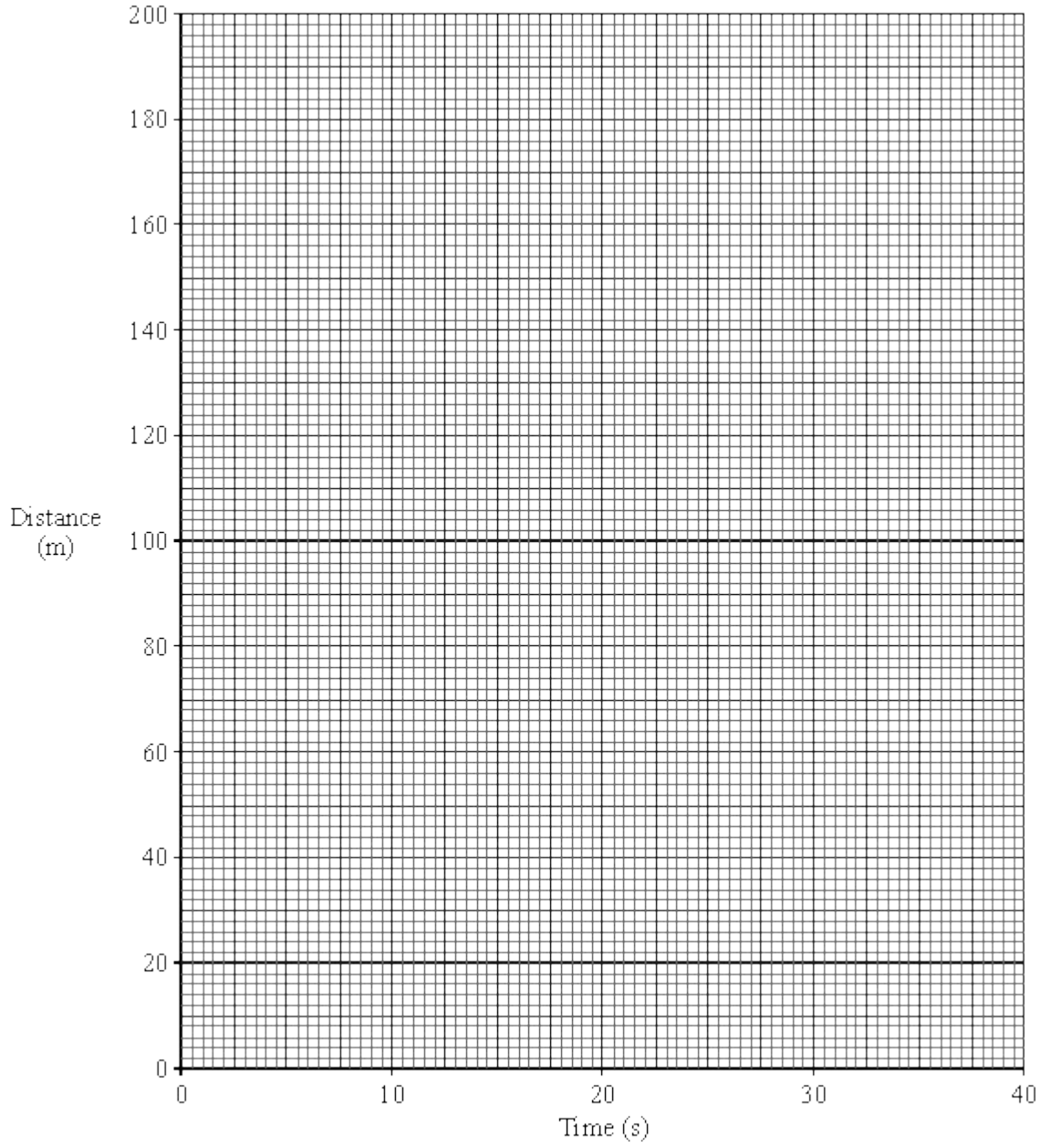
(3)

(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.

Distance travelled (m)	0	40	80	120	160	200
Time taken (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.

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(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.

_____

_____

_____

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(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)

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