1 (a) A car driver makes an emergency stop.

The chart shows the ‘thinking distance’ and the ‘braking distance’ needed to stop the car.

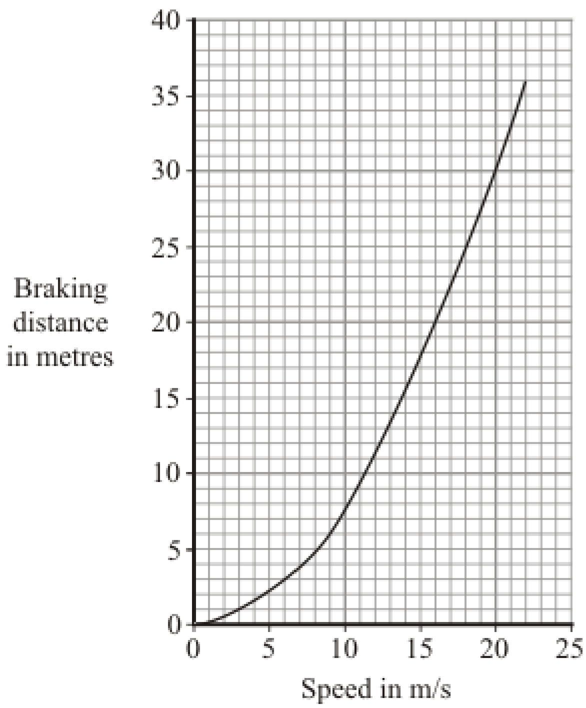
Calculate the total stopping distance of the car.

____

Stopping distance = _________________________ m

(1)

(b) The graph shows how the braking distance of a car driven on a dry road changes with the car’s speed.



The braking distance of the car on an icy road is longer than the braking distance of the car on a dry road.

(i) Draw a new line on the graph to show how the braking distance of the car on an icy road changes with speed.

(2)

(ii) Which **two** of the following would also increase the braking distance of the car?

Put a tick (✓) next to each of your answers.

rain on the road ☐

the driver having drunk alcohol ☐

car brakes in bad condition ☐

the driver having taken drugs ☐

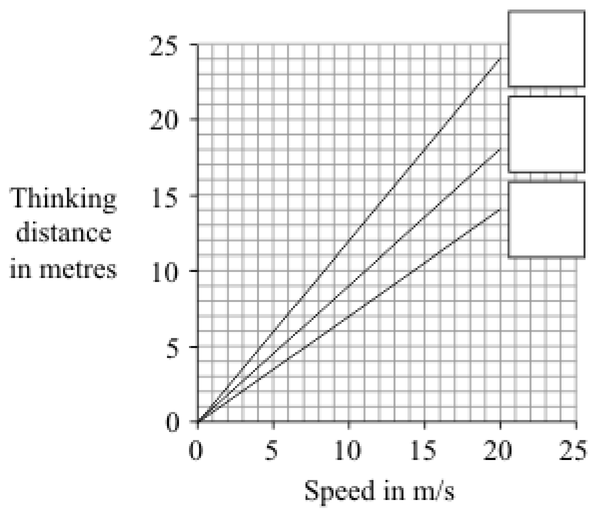
(2)

(c) The thinking distance depends on the driver's reaction time.

The table shows the reaction times of three people driving under different conditions.

Car driver	Condition	Reaction time in seconds
A	Wide awake with no distractions	0.7
B	Using a hands-free mobile phone	0.9
C	Very tired and listening to music	1.2

The graph lines show how the thinking distance for the three drivers, **A**, **B** and **C**, depends on how fast they are driving the car.



(i) Match each graph line to the correct driver by writing **A**, **B** or **C** in the box next to the correct line.

(2)

(ii) The information in the table cannot be used to tell if driver **C**'s reaction time is increased by being tired or by listening to music.

Explain why.

____

____

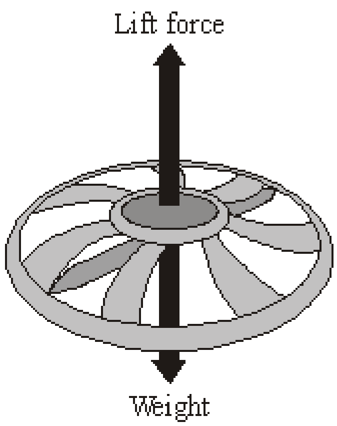
____

____

(2)

(Total 9 marks)

2 The diagram shows the forces on a small, radio-controlled, flying toy.



(a) (i) The mass of the toy is 0.06 kg.
Gravitational field strength = 10 N/kg

Calculate the weight of the toy.

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

____

____

Weight = ______________________________

(3)

(ii) Complete the following sentence by drawing a ring around the correct line in the box.

When the toy is hovering stationary in mid-air, the lift force is

bigger than the same as smaller than	the weight of the toy.

(1)

(b) When the motor inside the toy is switched off, the toy starts to *accelerate* downwards.

(i) What does the word *accelerate* mean?

____

(1)

(ii) What is the direction of the resultant force on the falling toy?

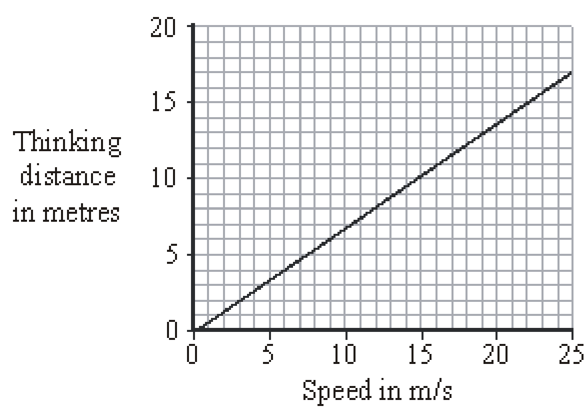
____

(1)

(Total 6 marks)

3 (a) A car driver takes a short time to react to an emergency before applying the brakes. The distance the car will travel during this time is called the 'thinking distance'.

The graph shows how the thinking distance of a driver depends on the speed of the car.



(i) What is the connection between thinking distance and speed?

____

(1)

(ii) Many people drive while they are tired.

Draw a new line on the graph to show how thinking distance changes with speed for a tired driver.

(1)

(iii) The graph was drawn using data given in the Highway Code.

Do you think that the data given in the Highway Code is likely to be reliable?

Draw a ring around your answer.

Yes **No** **Maybe**

Give a reason for your answer.

____

____

(1)

(b) The distance a car travels once the brakes are applied is called the ‘braking distance’.

(i) What is the relationship between thinking distance, braking distance and stopping distance?

____

(1)

(ii) State **two** factors that could increase the braking distance of a car at a speed of 15 m/s.

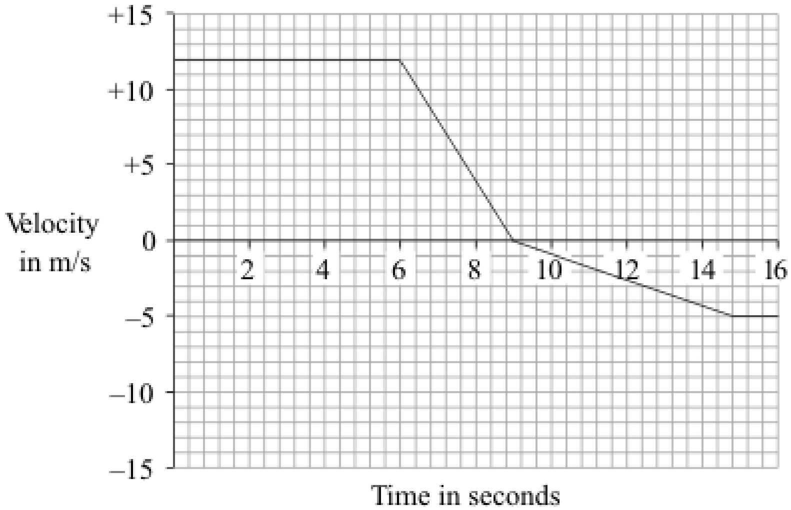
1. ____

2. ____

(2)

(Total 6 marks)

4 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)

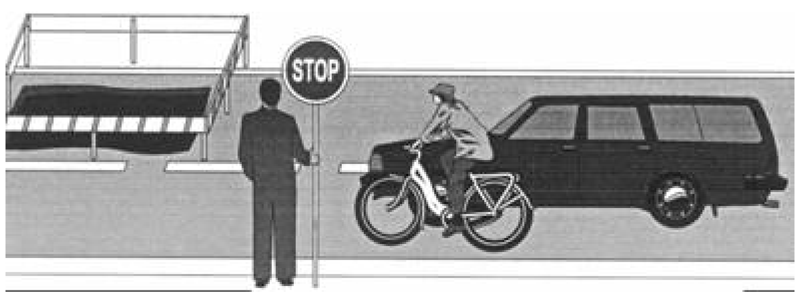
(b) At what time did the car change direction?

___ seconds

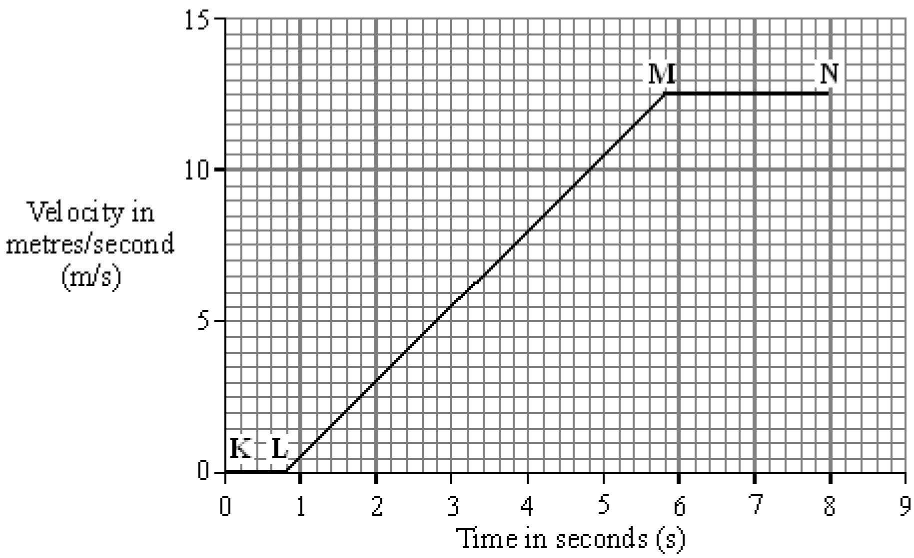
(1)

(Total 4 marks)

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



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)

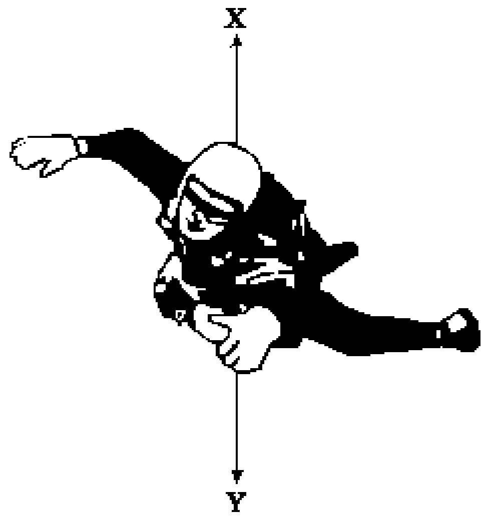
(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

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)

(Total 6 marks)

6 The diagram shows a sky-diver in free fall. Two forces, **X** and **Y**, act on the sky-diver.



(a) Complete these sentences by crossing out the **two** lines in each box that are wrong.

(i) Force **X** is caused by

friction gravity weight

. **(1)**

(ii) Force **Y** is caused by

air resistance friction gravity

. **(1)**

(b) The size of force **X** changes as the sky-diver falls. Describe the motion of the sky-diver when:

(i) force **X** is smaller than force **Y**,

____

____

(2)

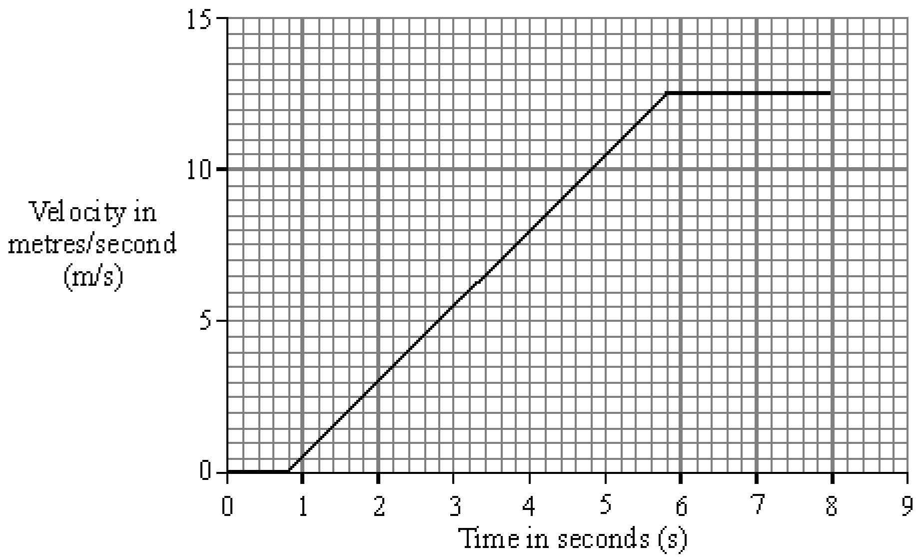
(ii) force **X** is equal to force **Y**.

____

____

(1)
(Total 5 marks)

7 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

____

(1)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

____

____

Distance = ________________________metres

(3)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

____

____

____

Acceleration = ___________________________________

(4)

(d) The mass of the car is 900 kg.

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

____

(1)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

____

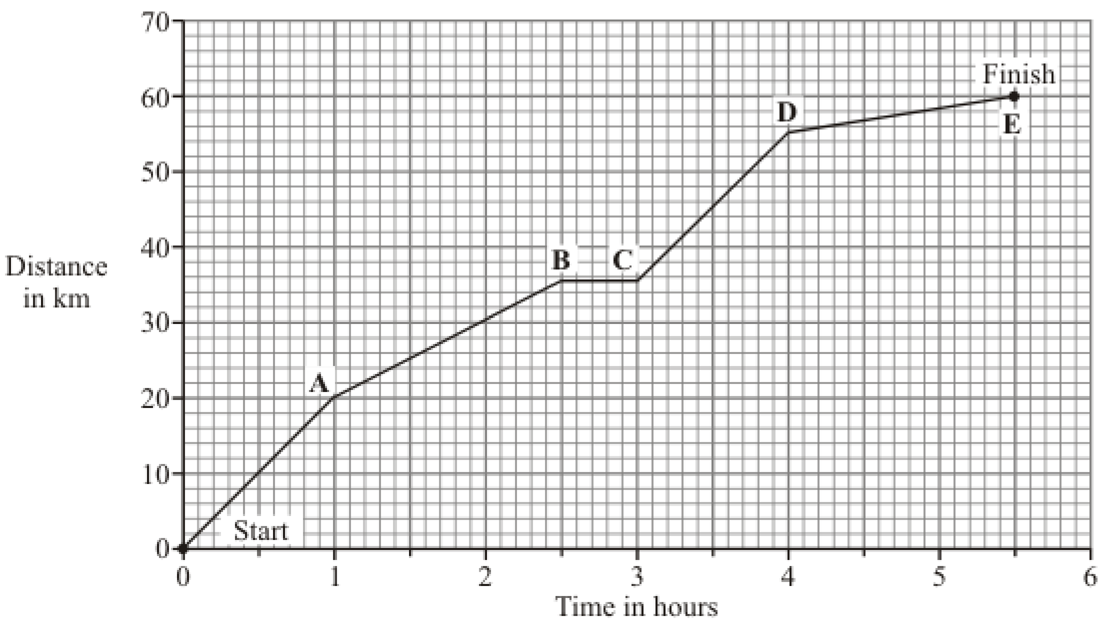
____

Force = ___________________________ newtons

(2)

(Total 11 marks)

8 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.

____

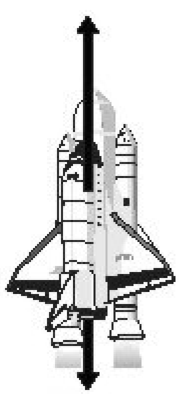
____

(2)

(Total 6 marks)

9 (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)

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

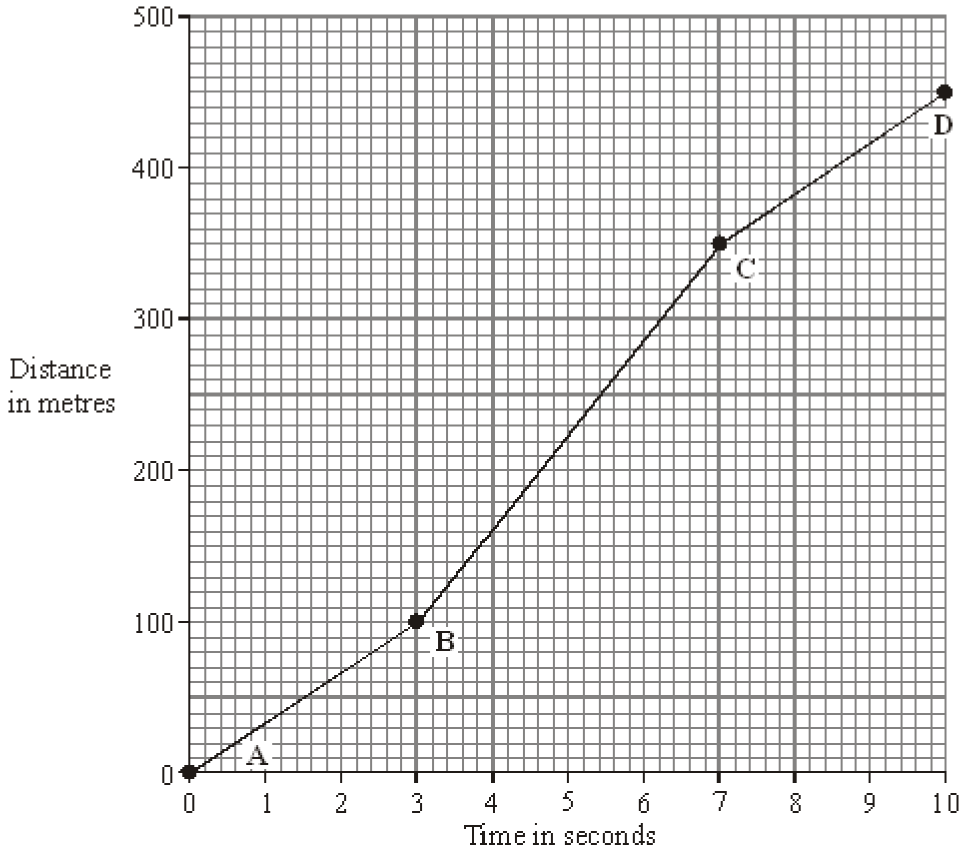
____

____

(1)

(Total 6 marks)

10 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.

___

___

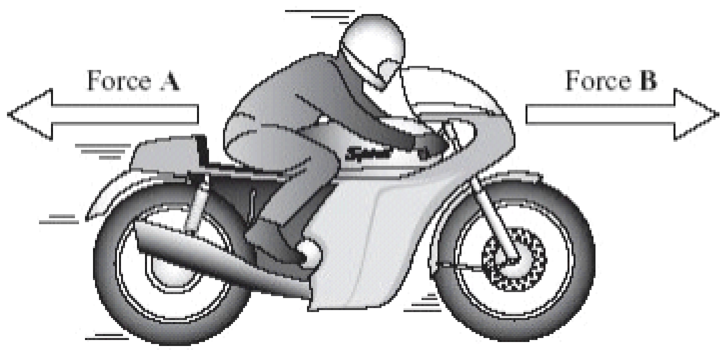
___

gradient = ___

(3)

(Total 6 marks)

11 (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**.

___

___

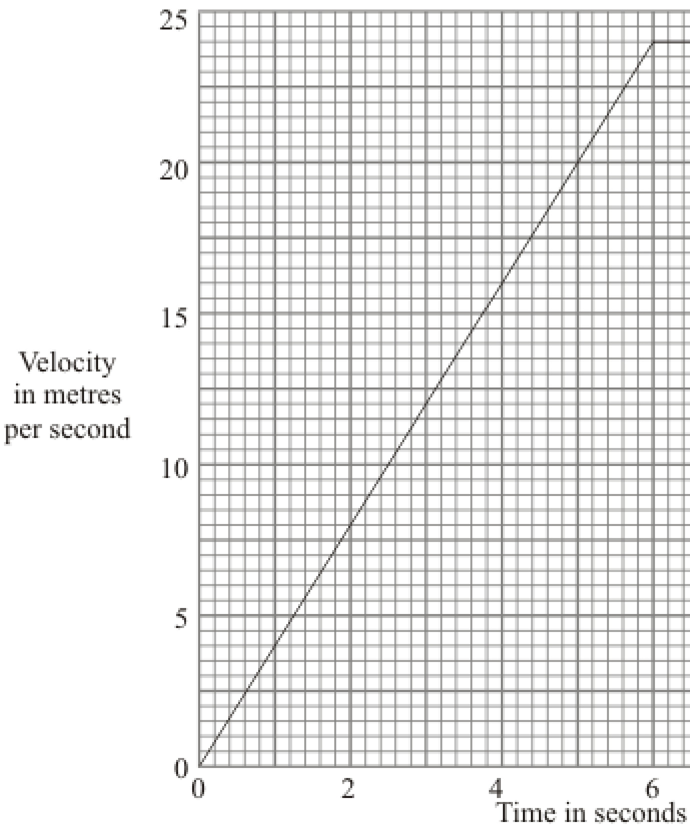
(2)

(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.



(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.

____

____

____

____

(2)

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

1. ____

____

2. ____

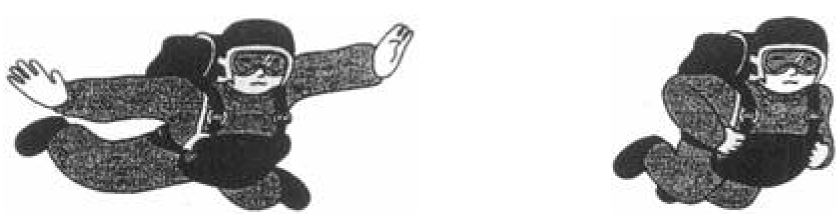
____

3. ____

____

(3)
(Total 13 marks)

12 (a) Two skydivers jump from a plane. Each holds a different position in the air.



A **B**

Adapted from Progress with Physics by Nick England, reproduced by permission of Hodder Arnold

Complete the following sentence.

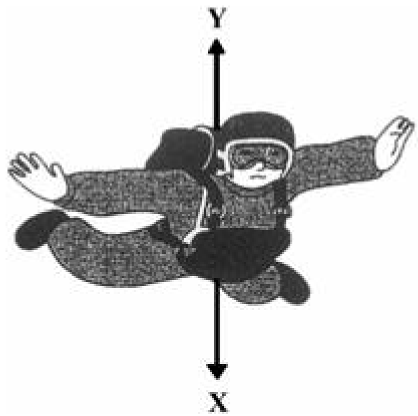
Skydiver ____________ will fall faster because ______________________________

____

____

(2)

The diagram shows the direction of the forces acting on one of the skydivers.



Adapted from Progress with Physics by Nick England, reproduced by permission of Hodder Arnold

(b) In the following sentences, cross out in each box the **two** lines that are wrong.

(i) Force **X** is caused by

air resistance friction gravity

(1)

(ii) Force **Y** is caused by

air resistance gravity weight

(1)

(iii) When force **X** is bigger than force **Y**, the speed of the

skydiver will

go up stay the same go down

(1)

(iv) After the parachute opens, force **X**

goes up stays the same goes down

(1)

(c) How does the area of an opened parachute affect the size of force **Y**?

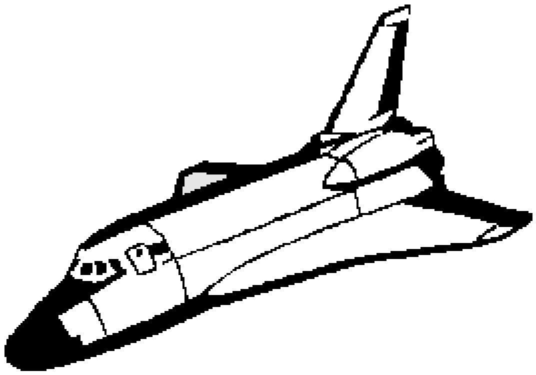
____

____

(1)

(Total 7 marks)

13 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.

kinetic energy = ½ mv^2

____

____

Kinetic energy = _______________ joules

(2)

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

____

____

(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.

____

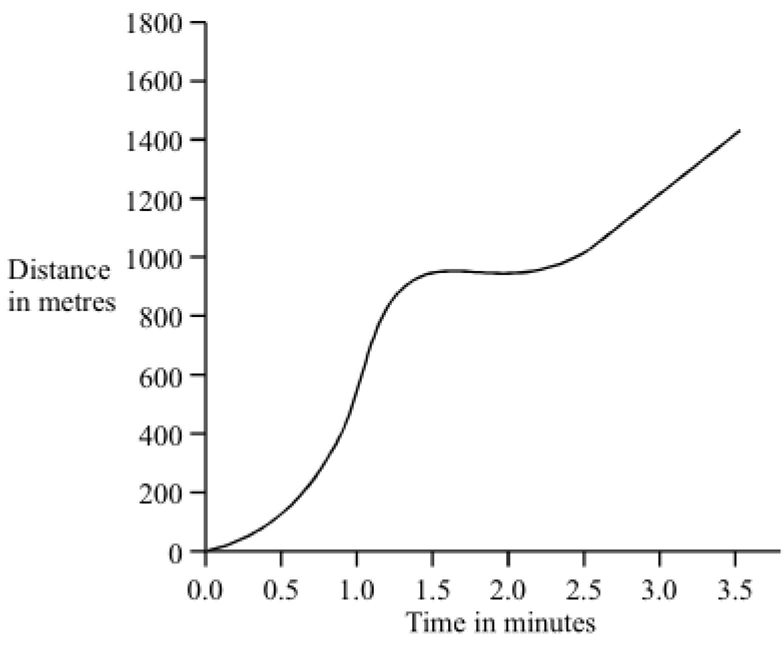
____

Force = ______________ newtons

(1)

(Total 9 marks)

14 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?

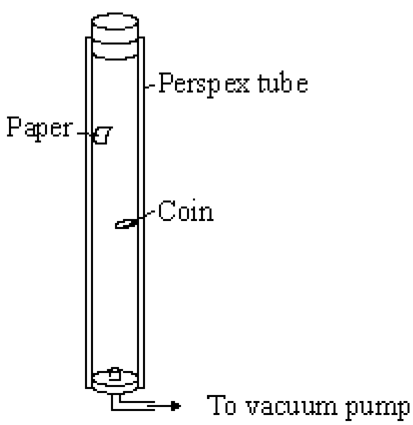
____

____

(1)

(Total 4 marks)

15 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?

____

____

(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. ____

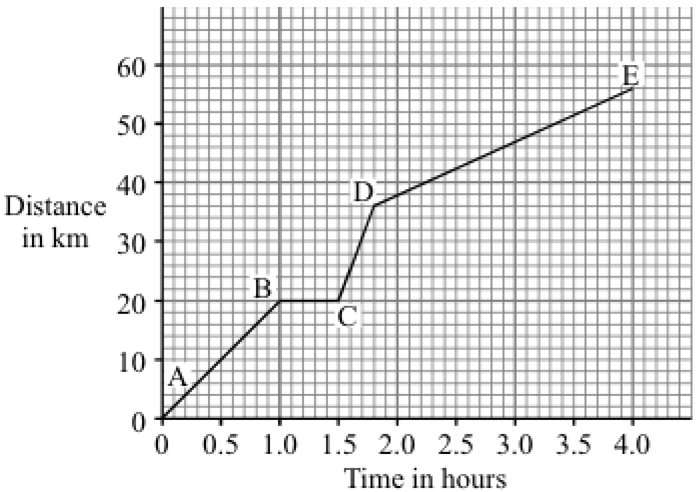
____

____

(2)

(Total 3 marks)

16 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)

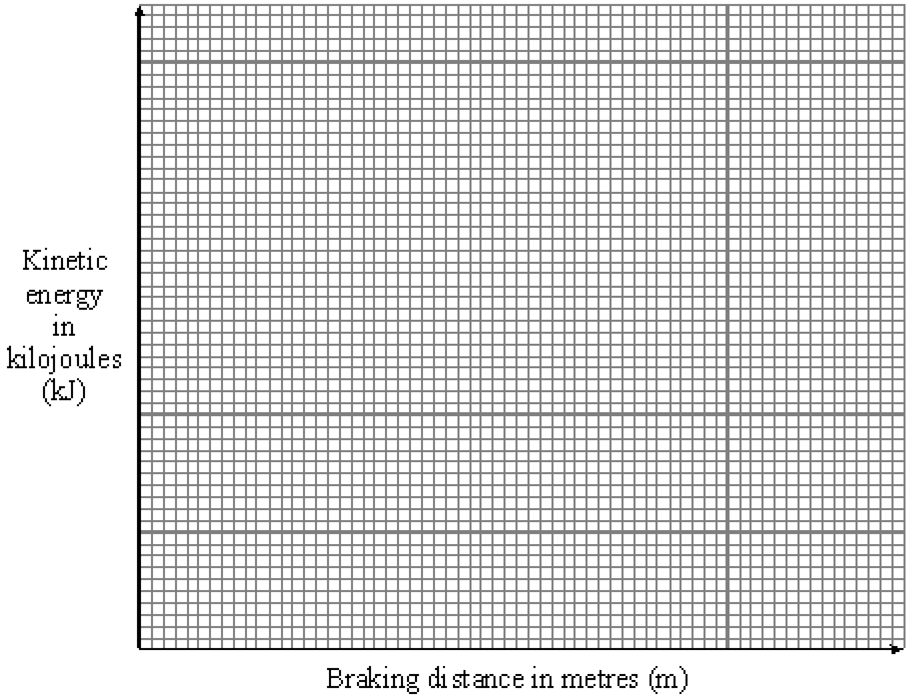
(Total 7 marks)

17 The table shows the braking distances for a car at different speeds and kinetic energy. The braking distance is how far the car travels once the brakes have been applied.

Braking distance in m	**Speed of car in m/s**	**Kinetic energy of car in kJ**
5	10	40
12	15	90
20	20	160
33	25	250
45	30	360

(a) A student suggests, “*the braking distance is directly proportional to the kinetic energy*.”

(i) Draw a line graph to test this suggestion.



(3)

(ii) Does the graph show that the student’s suggestion was correct or incorrect? Give a reason for your answer.

____

____

(1)

(iii) Use your graph and the equation for kinetic energy to predict a braking distance for a speed of 35 metres per second (m/s). The mass of the car is 800 kilograms (kg). Show clearly how you obtain your answer.

____

____

Braking distance = ____________________ m

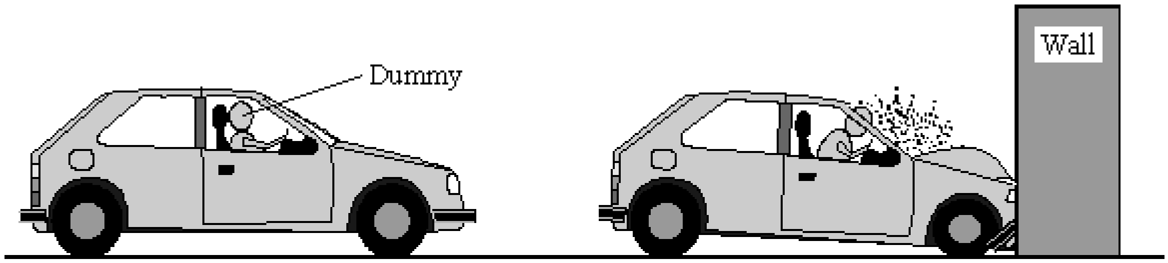
(2)

(iv) State **one** factor, apart from speed, which would increase the car’s braking distance.

____

(1)

(b) The diagram shows a car before and during a crash test. The car hits the wall at 14 metres per second (m/s) and takes 0.25 seconds (s) to stop.



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

____

(1)

(ii) Calculate the deceleration of the car.

____

Deceleration = ____________________ m/s^2

(1)

(iii) In an accident the crumple zone at the front of a car collapses progressively. This increases the time it takes the car to stop. In a front end collision the injury to the car passengers should be reduced. Explain why. The answer has been started for you.

By increasing the time it takes for the car to stop, the ___________________

____

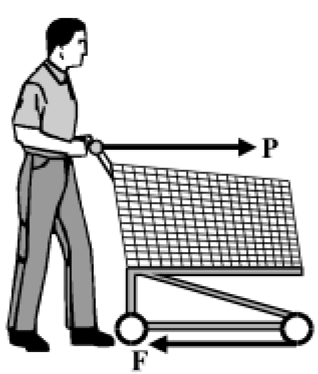
____

____

(2)

(Total 11 marks)

18 (a) A shopping trolley is being pushed at a constant speed. The arrows represent the horizontal forces on the trolley.

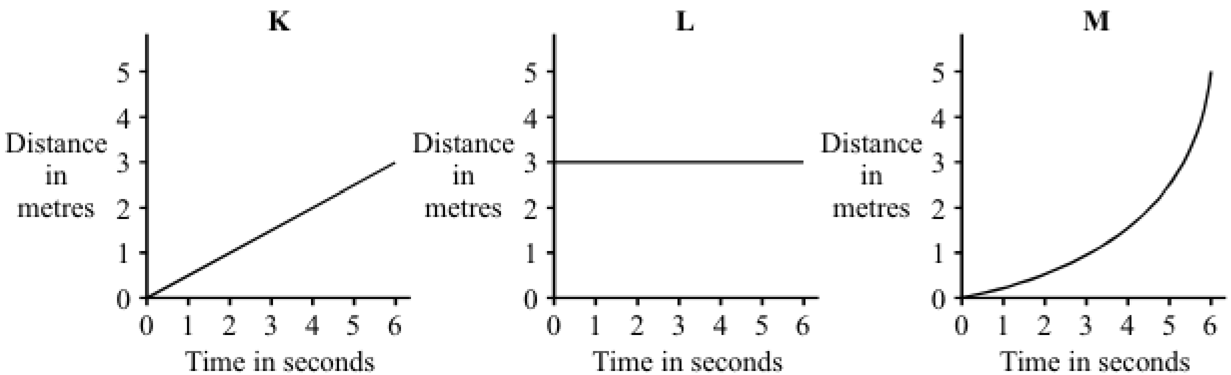


(i) How big is force **P** compared to force **F**?

____

(1)

(ii) Which **one** of the distance-time graphs, **K**, **L** or **M**, shows the motion of the trolley? Draw a circle around your answer.



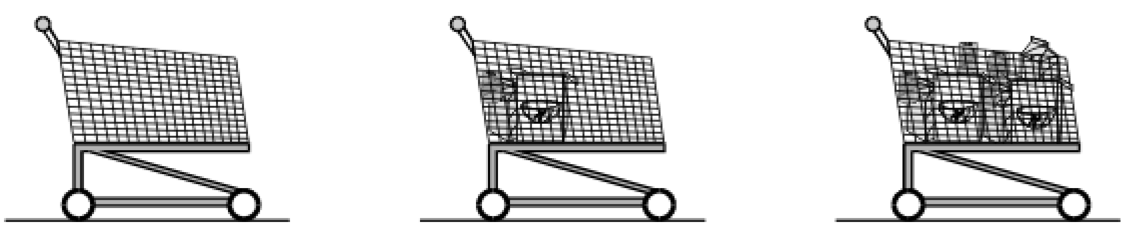
(1)

(b) Complete the sentence by crossing out the **two** words in the box that are wrong.

Acceleration is the rate of change of | energy. / speed. / velocity.

(1)

(c) Three trolleys, **A**, **B** and **C**, are pushed using the same size force. The force causes each trolley to accelerate.



Which trolley will have the smallest acceleration?

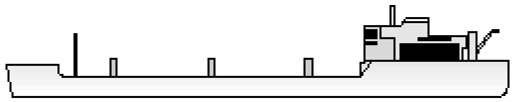
____

Give a reason for your answer.

____

(2)
(Total 5 marks)

19 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)

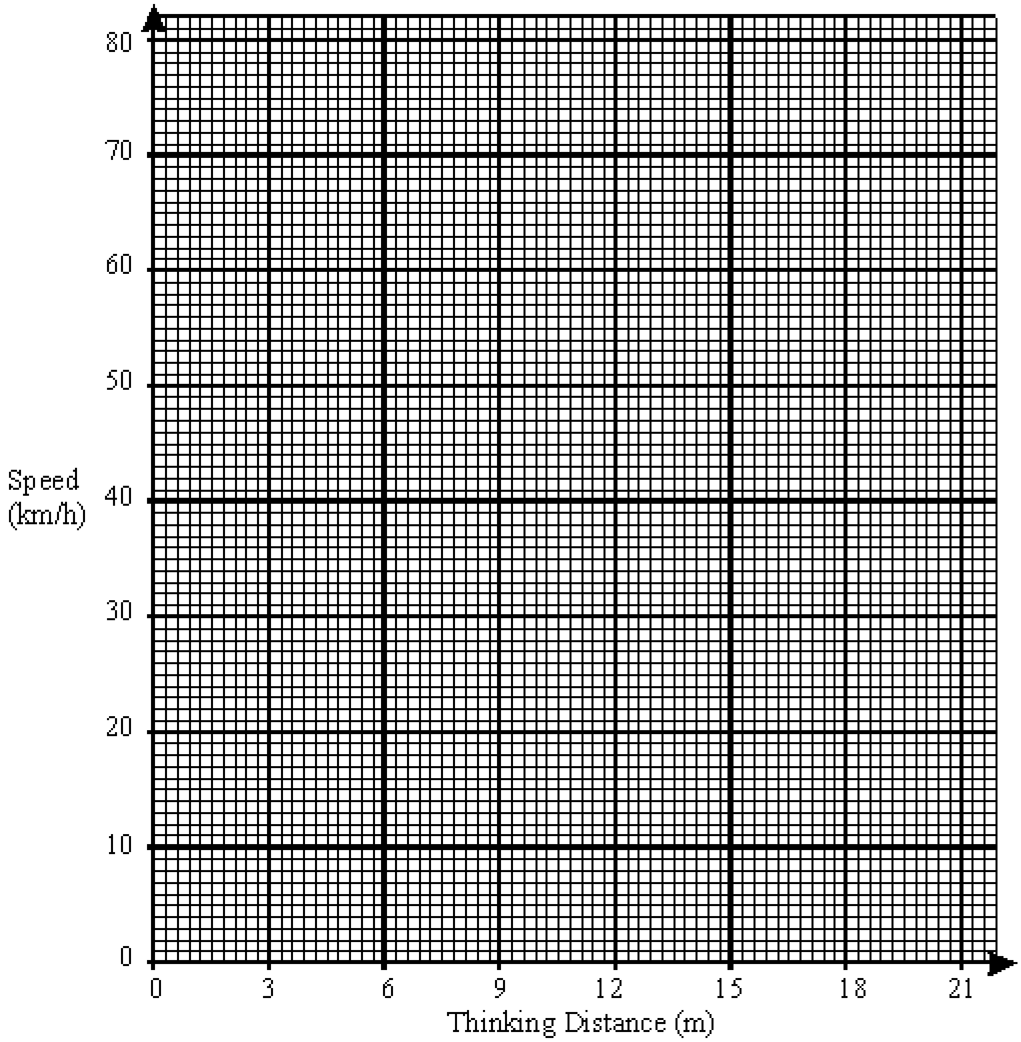
(Total 3 marks)

20 When a car driver has to react and apply the brakes quickly, the car travels some distance before stopping. Part of this distance is called the "thinking distance". This is how far the car travels while the driver reacts to a dangerous situation.

The table below shows the thinking distance (m) for various speeds (km/h).

Thinking distance (m)	0	9	12	15
Speed (km/h)	0	48	64	80

(a) On the graph paper below, draw a graph of the thinking distance against speed.



(2)

(b) Describe how thinking distance changes with speed.

____

____

(1)

(c) The time the driver spends thinking before applying the brakes is called the “thinking time”.

A driver drank two pints of lager. Some time later the thinking time of the driver was measured as 1.0 seconds.

(i) Calculate the thinking distance for this driver when driving at 9 m/s.

____

____

Answer ______________________ m

(1)

(ii) A speed of 9 m/s is the same as 32 km/h. Use your graph to find the thinking distance at 32 km/h for a driver who has not had a drink.

____

Answer ______________________ m

(1)

(iii) What has been the effect of the drink on the thinking distance of the driver?

____

____

(1)

(Total 6 marks)

21 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.

____

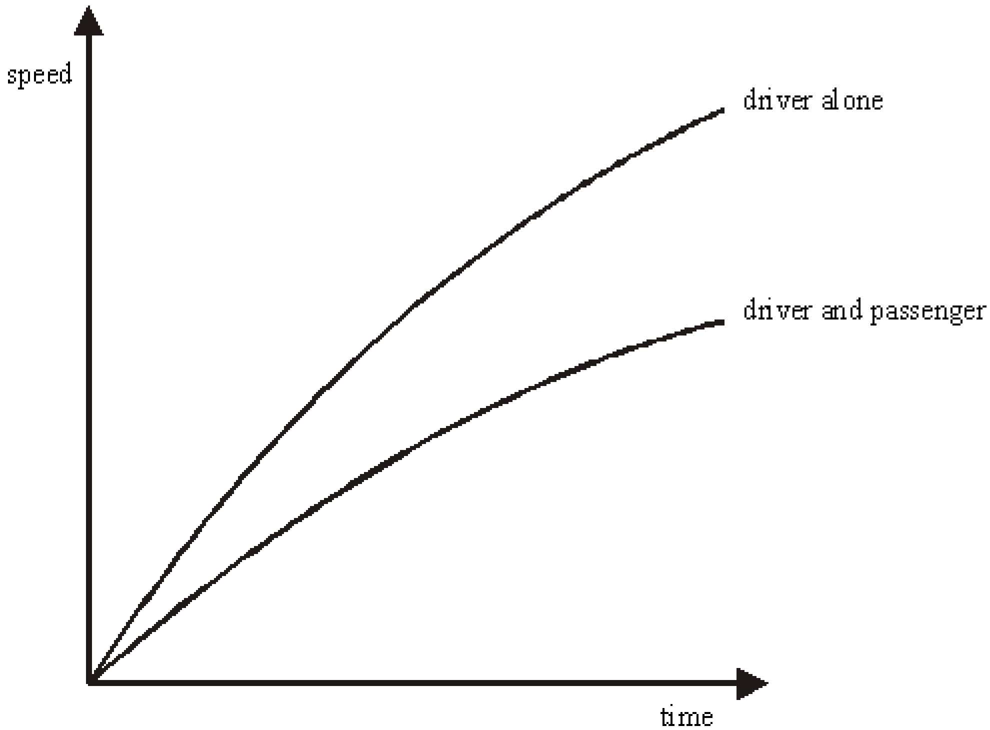
____

____

(3)

(Total 7 marks)

22 (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.



(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)

(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.

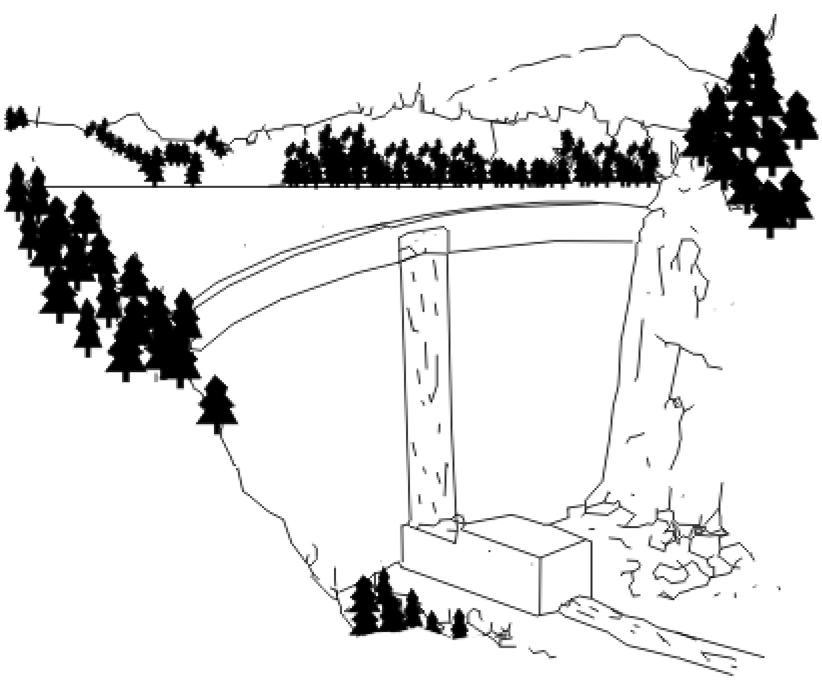
____

____

(2)

(Total 9 marks)

23 The diagram below shows water falling from a dam. Each minute 12 000 kg of water falls vertically into the pool at the bottom.



The time taken for the water to fall is 2 s and the acceleration of the water is 10 m/s^2.

(a) Assume the speed of the water at the bottom of the dam is zero. Calculate the speed of the water just before it hits the pool at the bottom.

___

___

(2)

(b) Use your answer to part (a) to calculate the average speed of the falling water.

___

(1)

(c) Calculate the height that the water falls.

___

___

(2)

(d) What weight of water falls into the pool each minute?

___

___

(2)

(e) How much work is done by gravity each minute as the water falls?

___

___

(2)

(f) A small electrical generator has been built at the foot of the waterfall. It uses the falling water to produce electrical power.

(i) How much energy is available from the falling water each minute?

___

(ii) How much power is available from the falling water?

___

___

(iii) If the generator is 20% efficient, calculate the electrical power output of the generator.

____

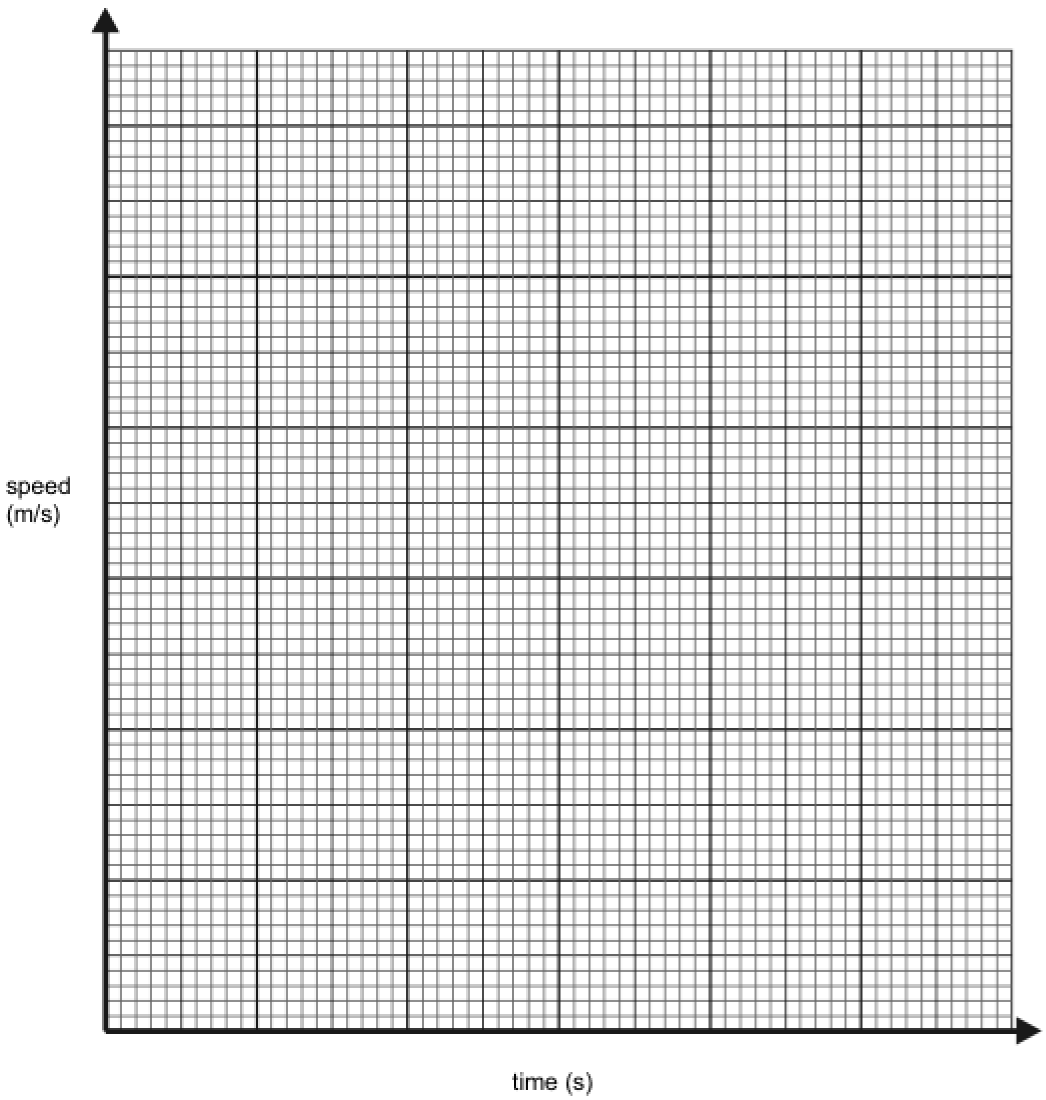
____

(4)

(Total 13 marks)

24 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.



(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.

____

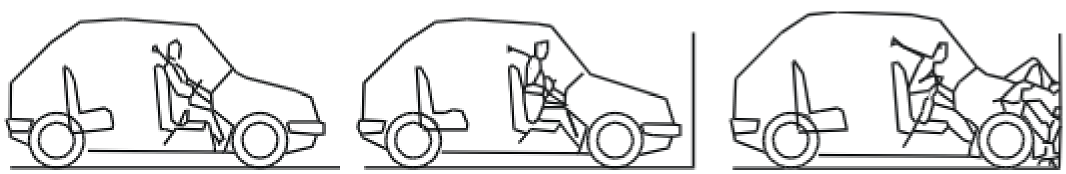
____

____

Answer = __________________ N

(3)

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



(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.

____

____

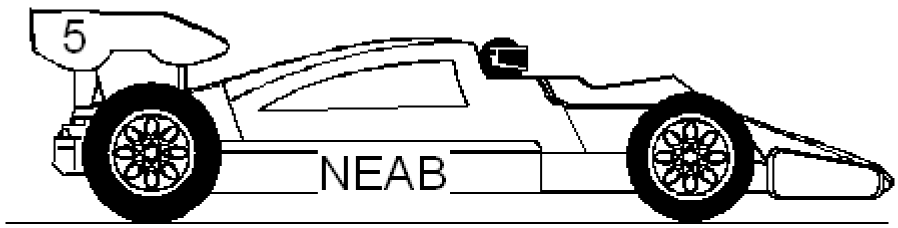
____

____

(8)

(Total 17 marks)

25 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.

____

____

____

____

____

____

(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.

____

____

____

____

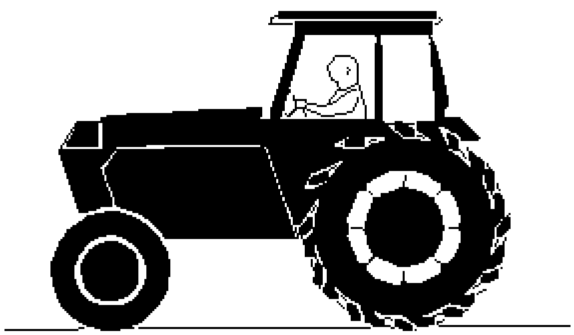
____

____

(12)

(Total 16 marks)

26 (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?

____

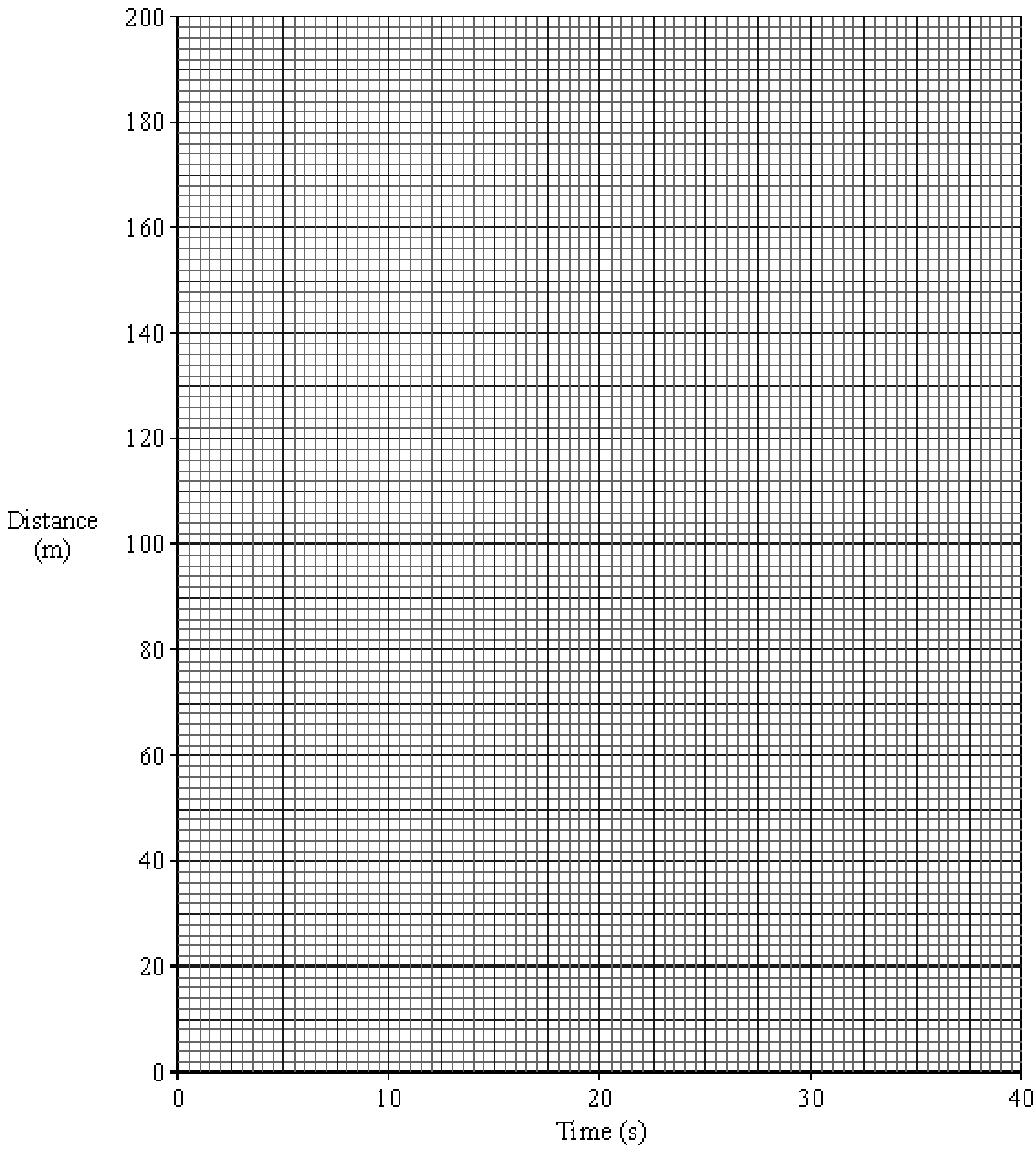
____

(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.

____

____

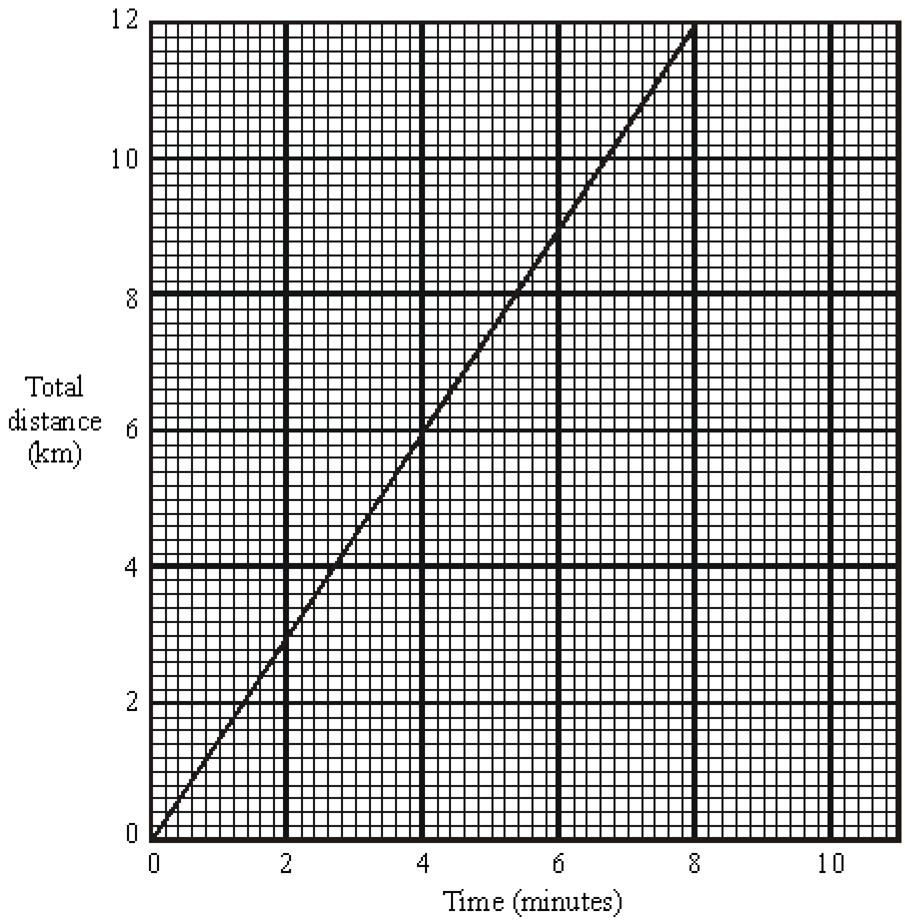
____

____ Acceleration = ____________ m/s^2

(3)

(Total 15 marks)

27 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.

____

____

____

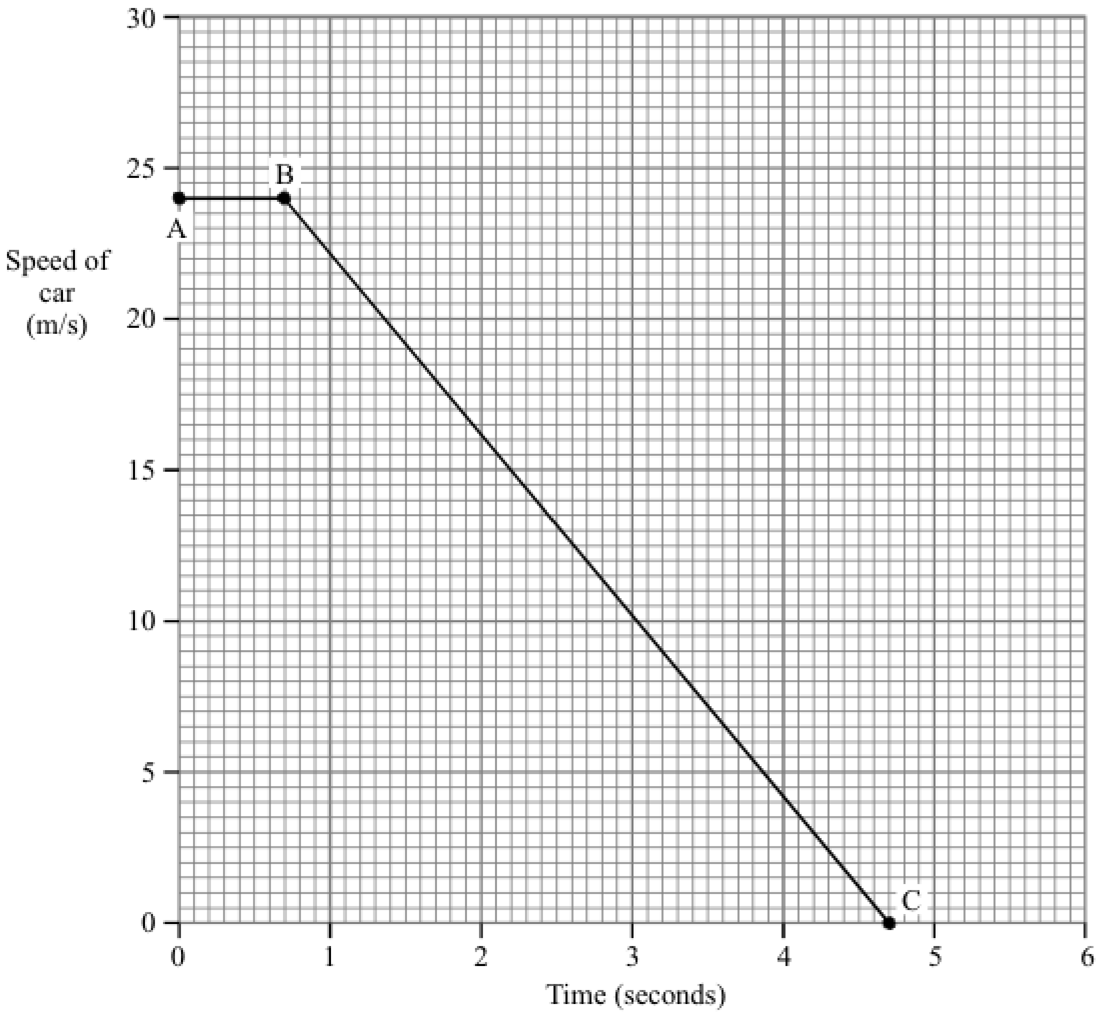
____

____

(4)
(Total 6 marks)

28 A car driver sees a dog on the road ahead and has to make an emergency stop.

The graph shows how the speed of the car changes with time after the driver first sees the dog.



(a) Which part of the graph represents the "reaction time" or "thinking time" of the driver?

____

(1)

(b) (i) What is the thinking time of the driver?

Time ____________ seconds

(1)

(ii) Calculate the distance travelled by the car in this thinking time.

____

____

____

Distance ___________________ m

(3)

(c) Calculate the acceleration of the car after the brakes are applied.

____

____

____

____

____

Acceleration ______________________

(4)

(d) Calculate the distance travelled by the car during braking.

____

____

____

____

____

Distance ________________________ m

(3)

(e) The mass of the car is 800 kg. Calculate the braking force.

____

____

____

____

____

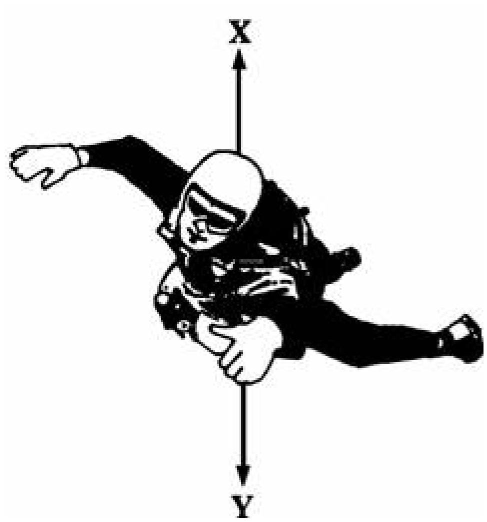
Braking force ____________________ N

(3)

(Total 15 marks)

29 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?

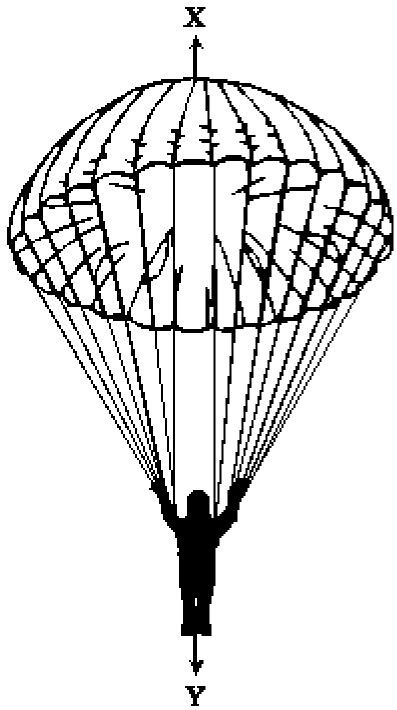
____

____

(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

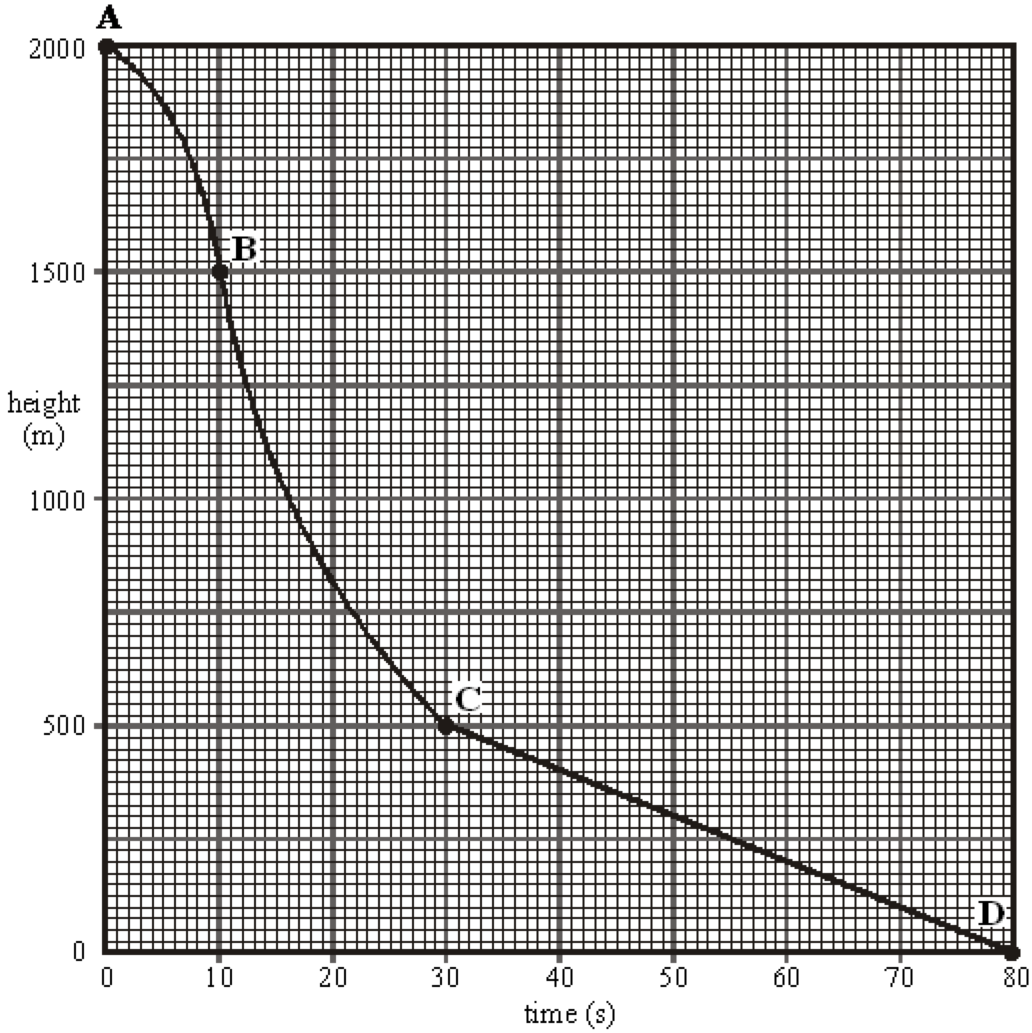
increased / stayed the same / decreased.

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.

____

____

____

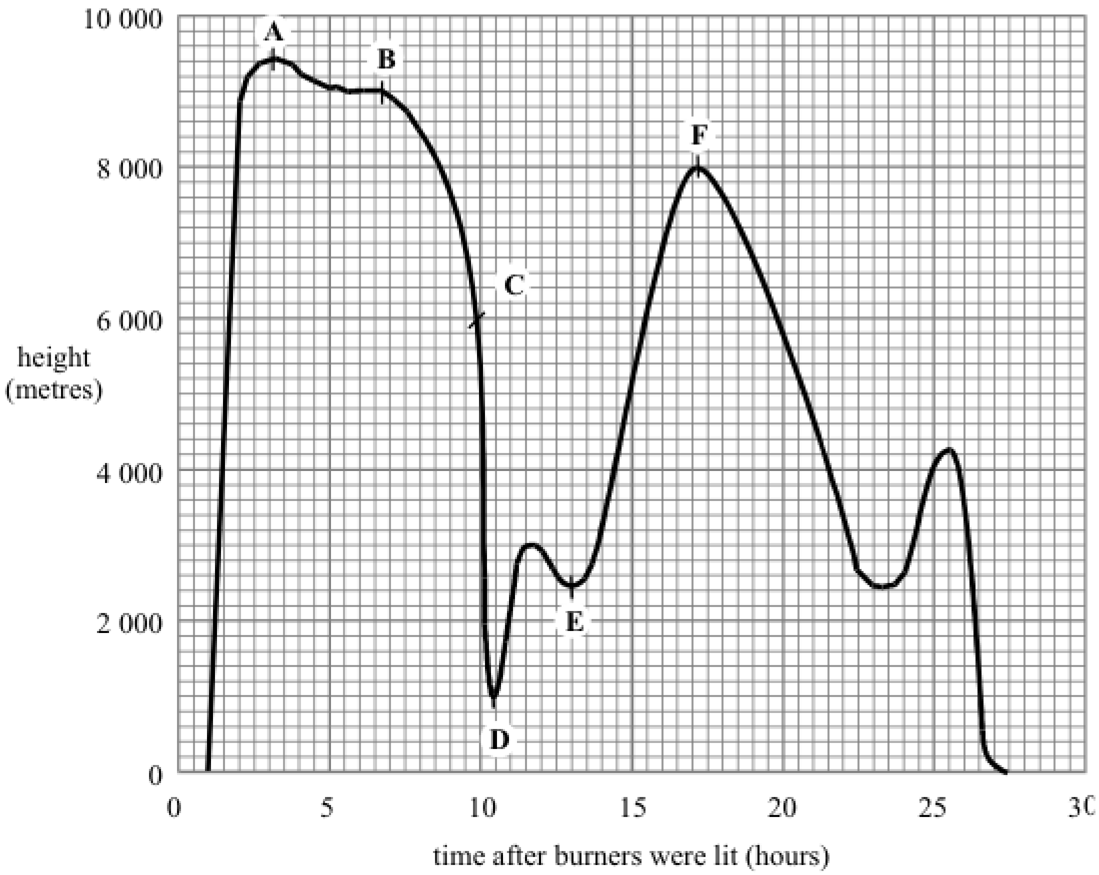
Speed ________________ m/s

(2)

(Total 14 marks)

30 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.

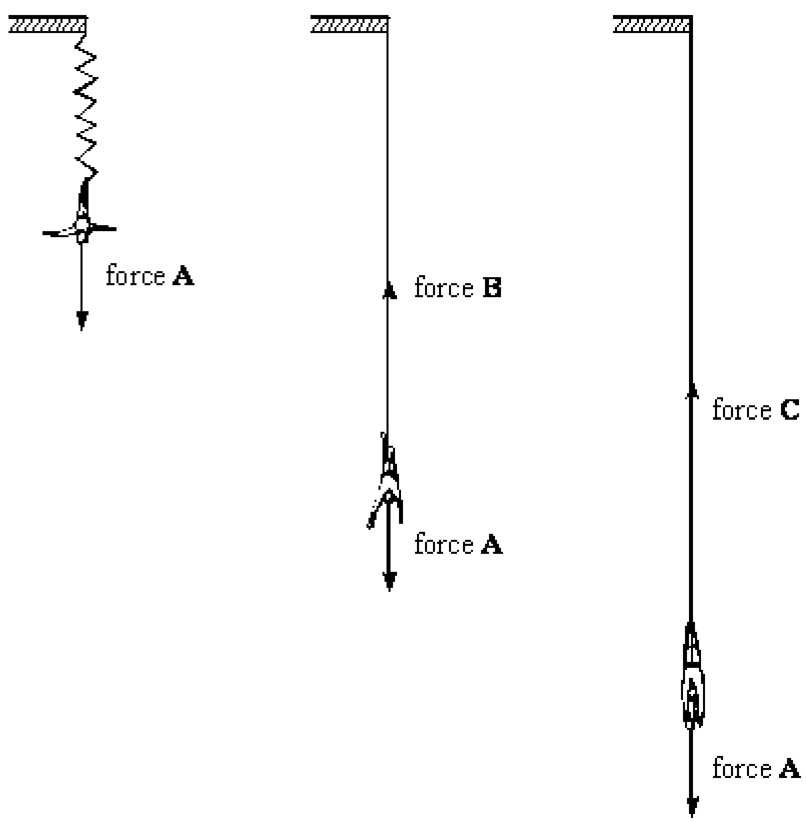
____

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

____

(3)
(Total 5 marks)

31 When a bungee-jump is made the jumper steps off a high platform. An elastic cord from the platform is tied to the jumper.
The diagram below shows different stages in a bungee-jump.
Forces **A**, **B** and **C** are forces acting on the jumper at each stage.



moving down large acceleration	moving down small acceleration	moving down slowing acceleration
diagram **X**	diagram **Y**	diagram **Z**

(a) Name force **A**.

____

(1)

(b) The motion of the jumper is shown in the diagrams.
By comparing forces **A**, **B** and **C**, state how the motion is caused in:

(i) diagram **X**;

____

(ii) diagram **Y**;

____

(iii) diagram **Z.**

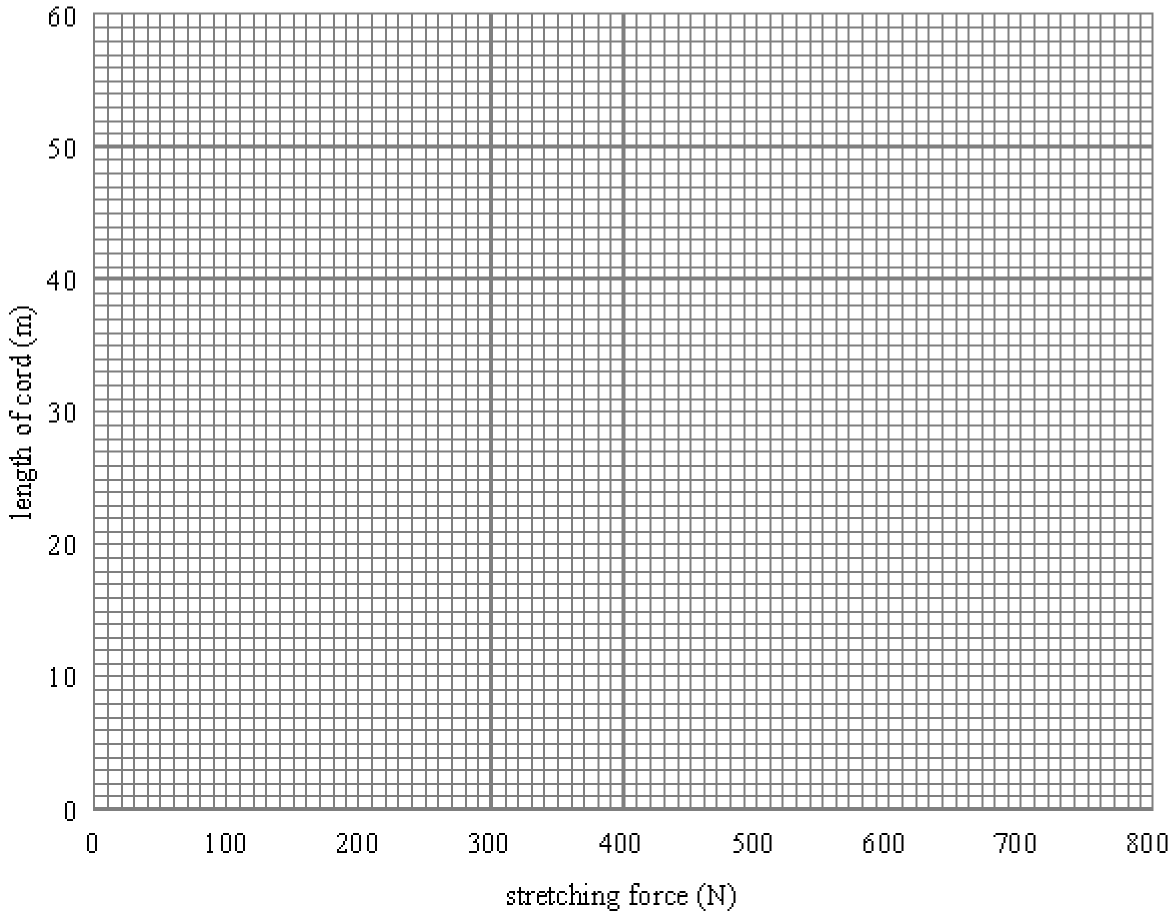
____

(3)

(c) The table gives results for a bungee cord when it is being stretched.

STRETCHING FORCE (N)	100	200	400	600	800
LENGTH OF CORD (m)	20	24	32	40	48

(i) Plot a graph of these results on the graph paper.



(3)

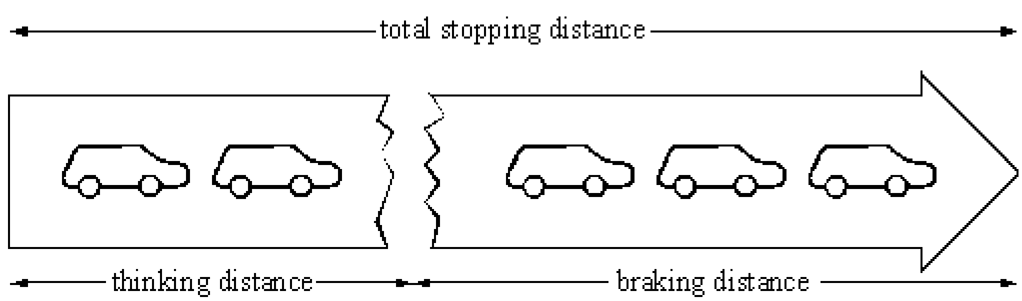
(ii) Use the graph to find the length of the cord before it was stretched.

Length __________ m

(1)

(Total 8 marks)

32 The Highway Code gives tables of the shortest stopping distances for cars travelling at various speeds. An extract from the Highway Code is given below.



thinking distance + braking distance = total stopping distance

(a) A driver's reaction time is 0.7 s.

(i) Write down **two** factors which could increase a driver's reaction time.

1. ______________________________

2. ______________________________

(2)

(ii) What effect does an increase in reaction time have on:

A thinking distance; ______________________________

B braking distance; ______________________________

C total stopping distance? ______________________________

(3)

(b) Explain why the braking distance would change on a wet road.

____

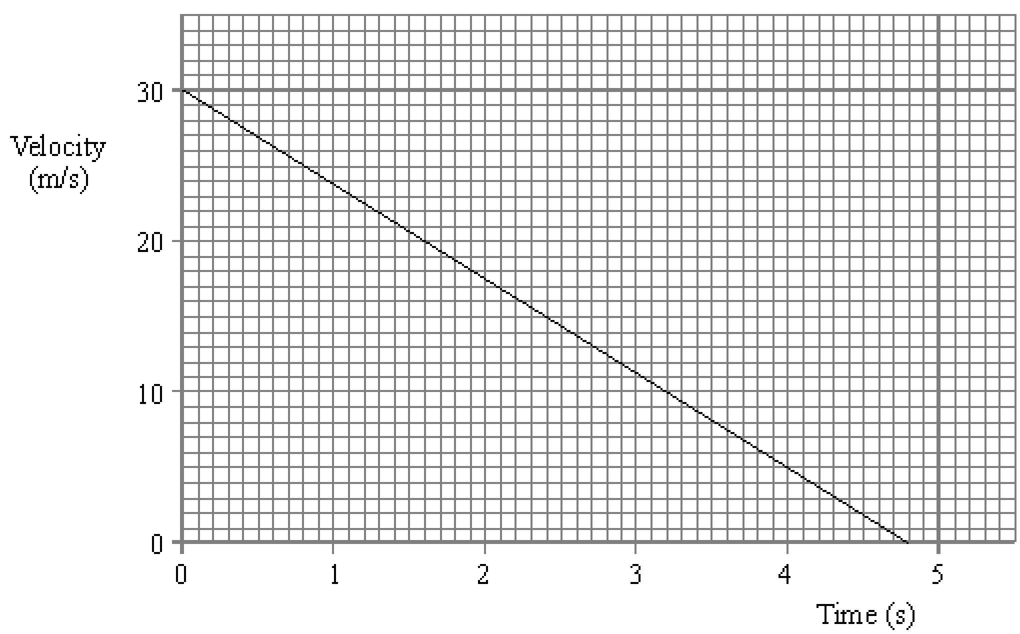
____

____

____

(2)

(c) A car was travelling at 30 m/s. The driver braked. The graph below is a velocity-time graph showing the velocity of the car during braking.



Calculate:

(i) the rate at which the velocity decreases (deceleration);

____

____

Rate _____________ m/s^2

(2)

(ii) the braking force, if the mass of the car is 900 kg;

____

____

Braking force ________________ N

(2)

(iii) the braking distance.

____

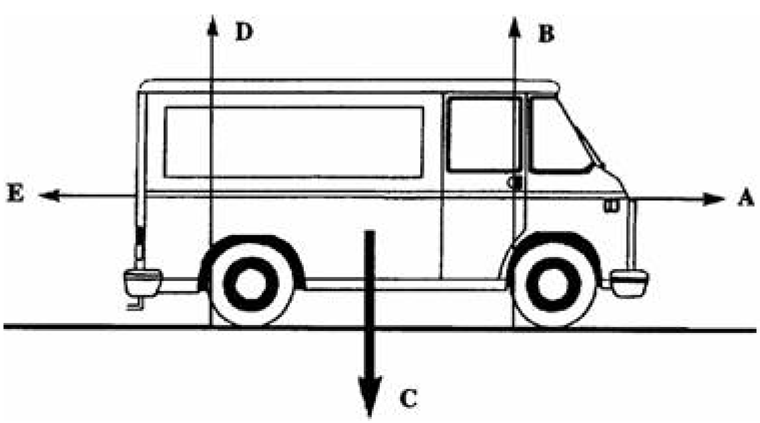
____

Braking distance _______________ m

(2)

(Total 13 marks)

33



Five forces, **A**, **B**, **C**, **D** and **E** act on the van.

(a) Complete the following sentences by choosing the correct forces from **A** to **E**.

Force ________ is the forward force from the engine.

Force ________ is the force resisting the van's motion.

(1)

(b) The size of forces **A** and **E** can change.
Complete the table to show how big force **A** is compared to force **E** for each motion of the van.
Do this by placing a tick in the correct box.
The first one has been done for you.

MOTION OF VAN	FORCE **A** SMALLER THAN FORCE **E**	FORCE **A** EQUAL TO FORCE **E**	FORCE **A** BIGGER THAN FORCE **E**
Not moving			
Speeding up			
Constant speed			
Slowing down			

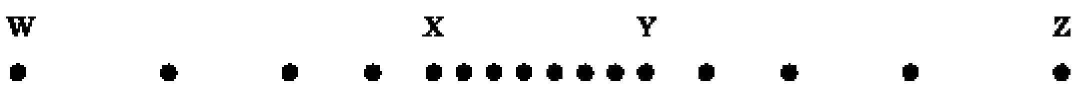
(3)

(c) When is force **E** zero?

____

(1)

(d) The van has a fault and leaks one drop of oil every second.
The diagram below shows the oil drops left on the road as the van moves from **W** to **Z**.



Describe the motion of the van as it moves from:

W to X ____

X to Y ____

Y to Z ____

(3)

(e) The driver and passengers wear seatbelts.
Seatbelts reduce the risk of injury if the van stops suddenly.

backwards **downwards** **force** **forwards** **mass** **weight**

Complete the following sentences, using words from the list above, to explain why the risk of injury is reduced if the van stops suddenly.

A large ____________________ is needed to stop the van suddenly.

The driver and passengers would continue to move ____________________ .

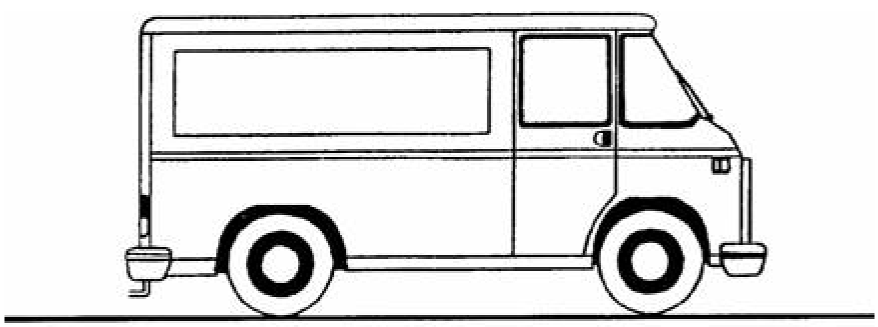
The seatbelts supply a ____________________ force to keep the driver and passengers

in their seats.

(3)

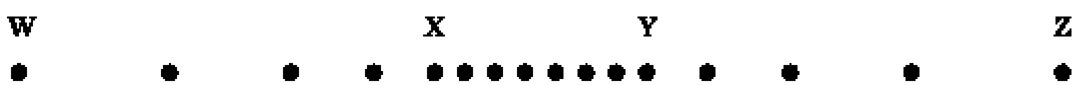
(Total 11 marks)

34



(a) The van shown above has a fault and leaks one drop of oil every second.

The diagram below shows the oil drops left on the road as the van moves from **W** to **Z**.



Describe the motion of the van as it moves from:

W to **X** ____

____

X to **Y** ____

____

Y to **Z** ____

____

(3)

(b) The van was driven for 20 seconds at a speed of 30m/s.

Calculate the distance travelled.

____

____

____

Distance ___________ m

(2)

(c) The van was travelling at 30m/s. It slowed to a stop in 12 seconds.

Calculate the van's acceleration.

____

____

____

Acceleration ___________ m/s^2

(3)

(d) The driver and passenger wear seatbelts. Seatbelts reduce the risk of injury.

Explain how seatbelts reduce the risk of injury.

____

____

____

____

____

____

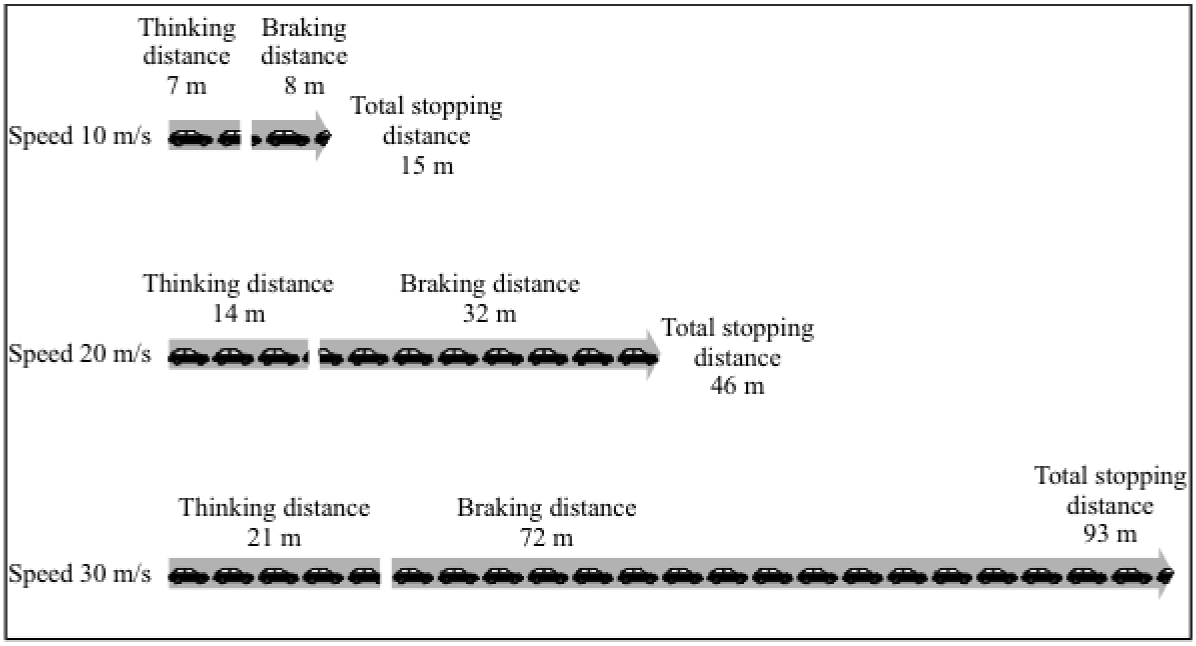
____

____

(4)

(Total 12 marks)

35 The diagram below shows the thinking distances, braking distances and total stopping distances at different speeds.



(a) Look at the total stopping distances at each speed.

Complete the sentence by choosing the correct words from the box.

distance	**force**	**mass**	**time**

The total stopping distance depends on the distance the car travels during the

driver's reaction ________________ and under the braking ________________ .

(2)

(b) Give **three** other factors that could cause the total stopping distance of a car to be greater. Do **not** give the factors in **Figure 1.**

1. ____

____

2. ____

____

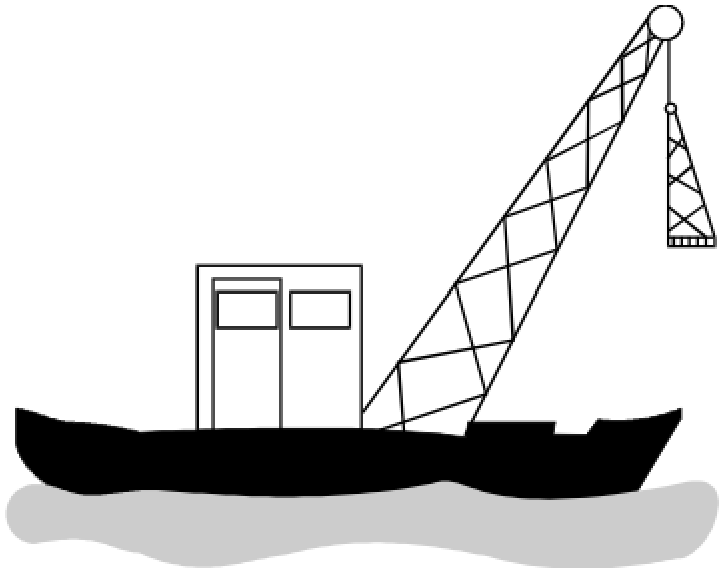
3. ____

____

(3)

(Total 5 marks)

36 A crane on a barge lifts a girder and then carries it along the river.



The girder has a weight of 1 000 000 N and is lifted to a height of 1500 cm.

(a) Complete the sentence.

The weight of the girder is caused by the Earth's gravitational field strength acting

on its ________________________________ .

(1)

(b) Calculate the work done in lifting the girder.

Write the equation you are going to use.

____

(1)

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

____

____

____

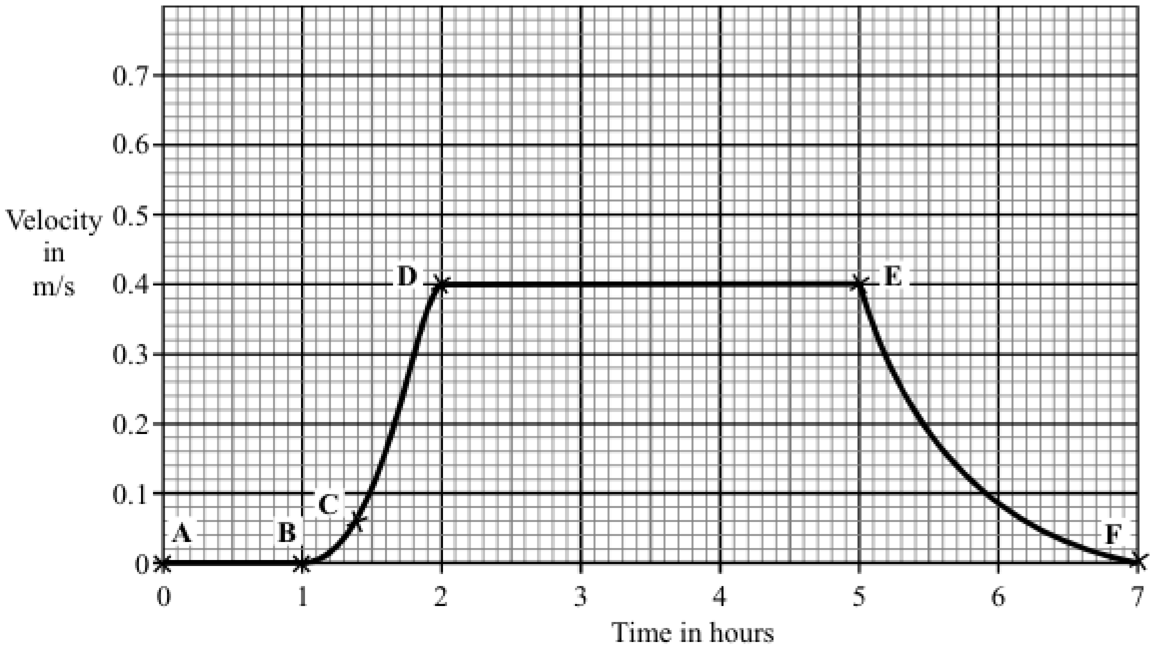
____

____

Work done = ________________________________

(3)

(c) The velocity–time graph represents the motion of the barge after the girder had been lifted.



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

Describe the motion of the barge over this period of seven hours. You must refer to the points **A**, **B**, **C**, **D**, **E** and **F** in your description.

____

____

____

____

____

____

____

____

(5)

(Total 10 marks)

37 When you transfer *energy* to a shopping trolley, the amount of *work done* depends on the *force* used and the *distance moved*.

Complete the table by using the correct units from the box.

joule (J)	**metre (m)**	**newton (N)**

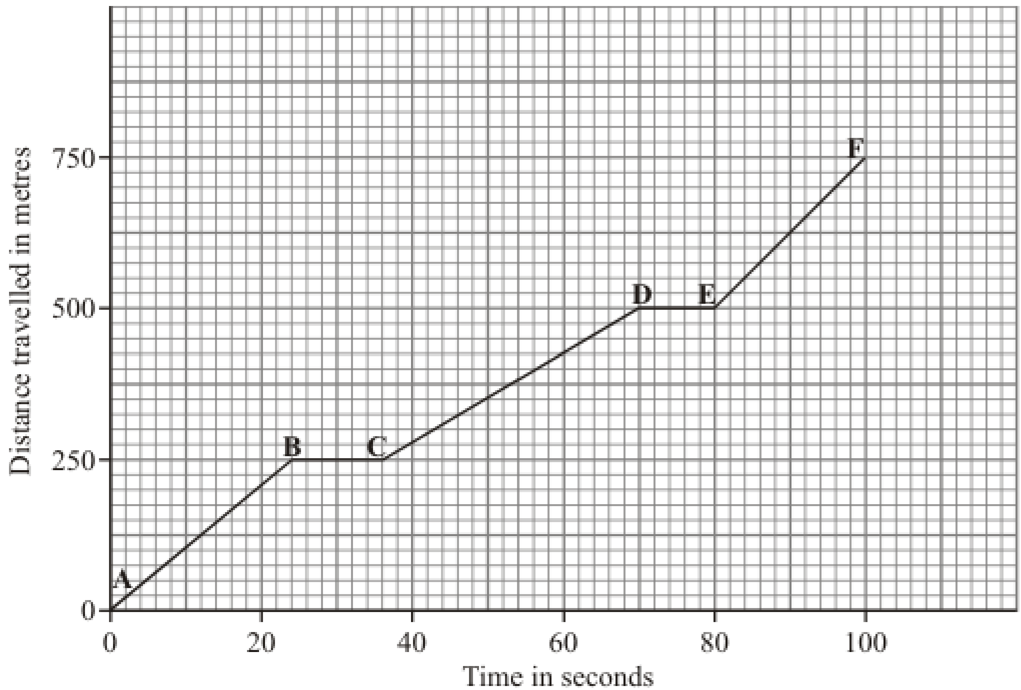
The first one has been done for you.

Quantity	Unit
energy (transferred)	joule
force	
distance (moved)	
work done	

(Total 2 marks)

38 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.

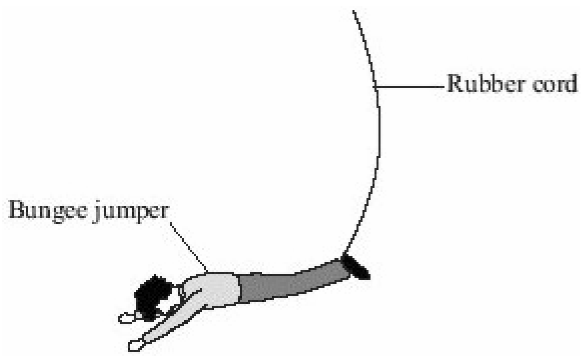
When a car has to stop, the **overall** stopping distance is greater if:

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

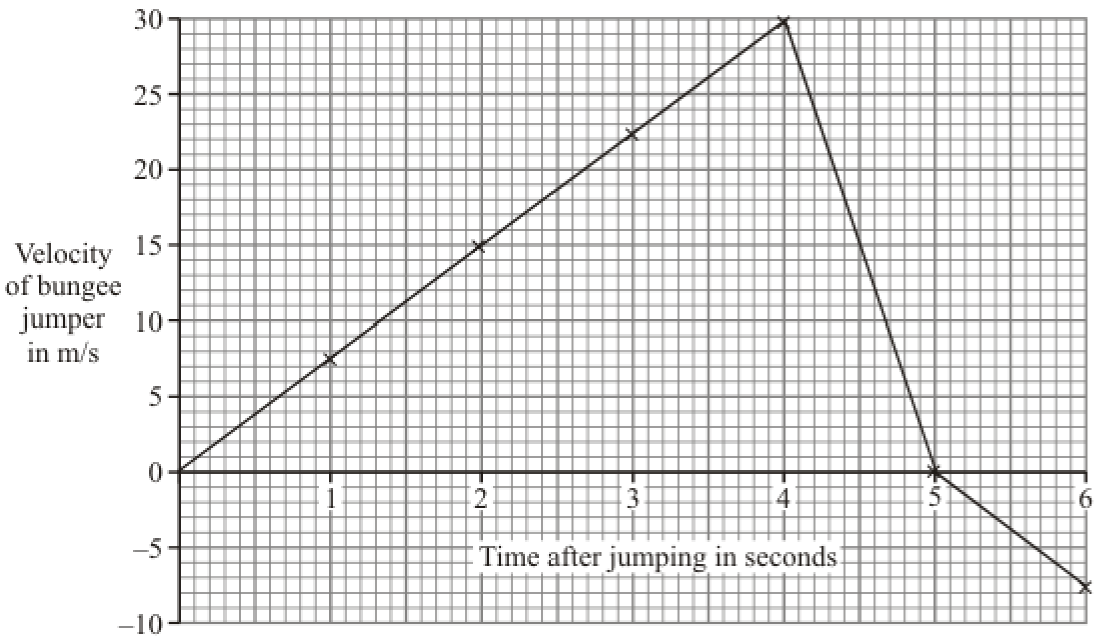
Also, the greater the speed of the car, then the greater the braking _____________ needed to stop in a certain time.

(3)
(Total 5 marks)

39 In bungee jumping, a fixed rubber cord is fastened to the jumper's ankles.



The graph shows how the bungee jumper's velocity changes during part of the jump.



(a) Calculate the acceleration of the bungee jumper between 2 and 4 seconds. Show your working.

____

____

____

____

Acceleration = _________________ m/s^2

(3)

(b) Describe, in as much detail as you can, what happens to the bungee jumper after 4 seconds.

____

____

____

____

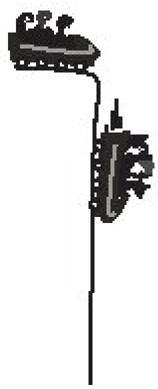
____

____

(3)

(Total 6 marks)

40 A rollercoaster car stops above a vertical drop. Suddenly it falls under gravity.



The drop is 60 metres high and at the bottom of the drop the car travels at 125 km/h.
The acceleration experienced by the people in the car is 10 m/s^2. The mass of the car and its passengers is 1210 kg.

Calculate the force exerted on the car and its passengers. Show your working.

____

____

____

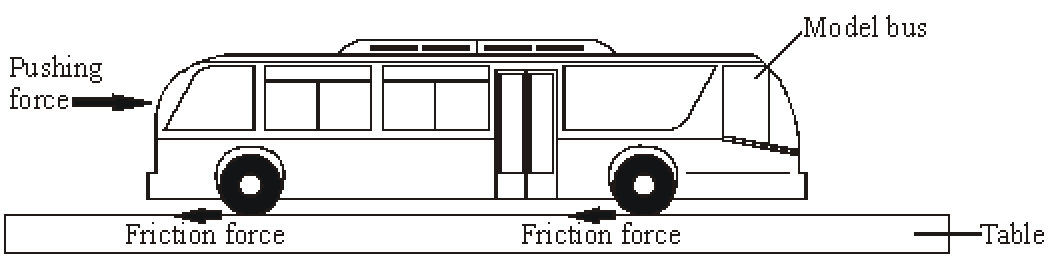
____

____

Force = _______________ N

(Total 3 marks)

41 (a) The model bus is being pushed on a table.



(i) At first the pushing force does **not** make the model bus move. Explain why.

____

____

(1)

(ii) Write down **two** things that happen as the pushing force increases.

1. ____

____

2. ____

____

(2)

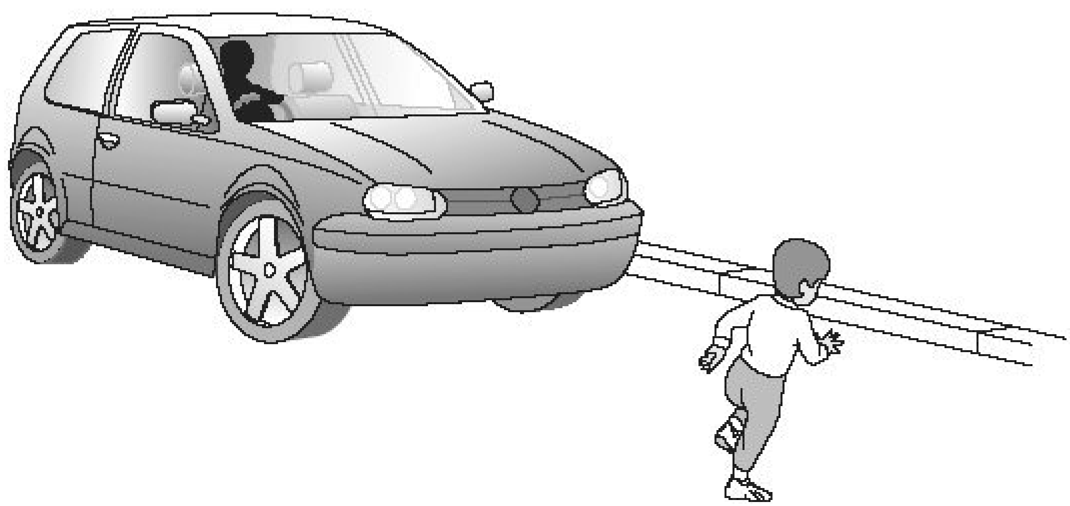
(iii) Complete the formula by choosing the correct words from the box.

acceleration	**distance moved**	**force applied**
speed	**time taken**	

Work done on the model bus = ________________ × ________________

(2)

(b) In this situation, the car driver needs to stop the car in the shortest possible distance.



(i) Complete the table by putting ticks (✓) to show which factors would make the stopping distance greater. The first one has been done for you.

Factor	Tick (✓) makes stopping distance greater
brakes are old and worn	✓
car is travelling fast	
driver has been drinking alcohol	
four new tyres are fitted	
hot, dry, sunny weather	
ice on the road	

(3)

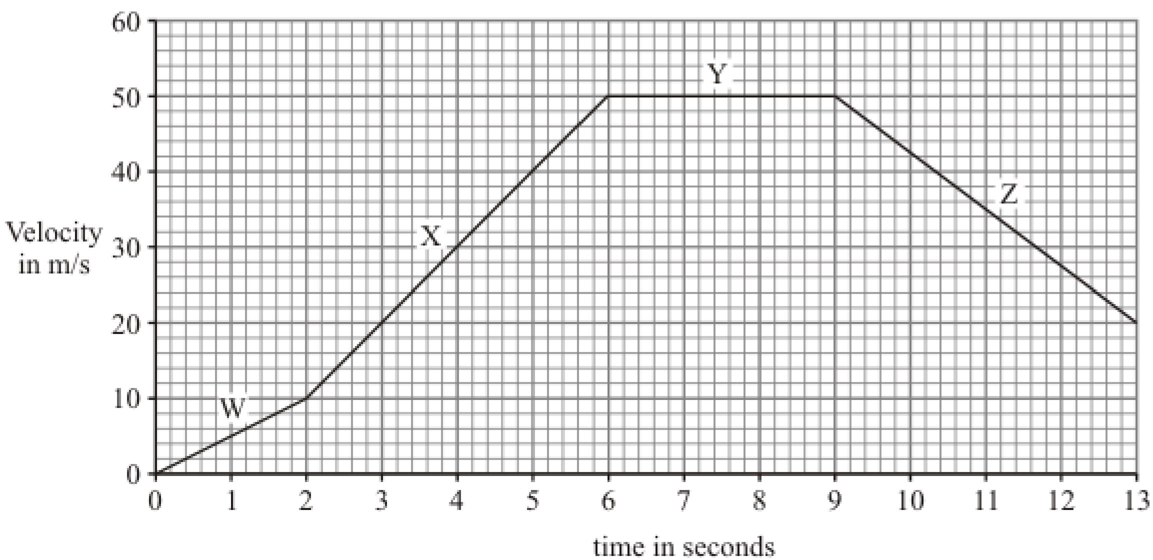
(ii) Complete the sentence by writing the correct words in the spaces.

The car will skid if the braking force is too big compared with the friction

between the car's __________________ and the __________________ .

(1)
(Total 9 marks)

42 The graph shows changes in the velocity of a racing car.



(a) Describe the motion of the racing car during:

(i) the period labelled **W**; ____

____

(1)

(ii) the period labelled **Y**. ____

____

(1)

(b) Calculate the acceleration of the racing car during the period labelled **X**.
Show clearly how you work out your answer and give the unit.

____

____

____

____

____

____

____

____

Acceleration = ________________________

(4)
(Total 6 marks)

43

(a) A driver may have to make an emergency stop.

Stopping distance = thinking distance + braking distance.

Give **three** different factors which affect the thinking distance or the braking distance. In your answer you should explain what effect **each** factor has on the stopping distance.

1. ____

____

____

____

2. ____

____

____

____

3. ____

____

____

____

(6)

(b) Complete the following sentences by writing in the **two** missing words.

Acceleration is the rate of change of ______________________________ .

The acceleration of a car depends on the force applied by the engine and the

______________________ of the car.

(2)

(c) A car moves because of the force applied by the engine.

Name **two** other forces which act on the car when it is moving. Give the direction in which **each** of these factors acts.

1. ____

Direction of this force ____

2. ____

Direction of this force ____

(4)

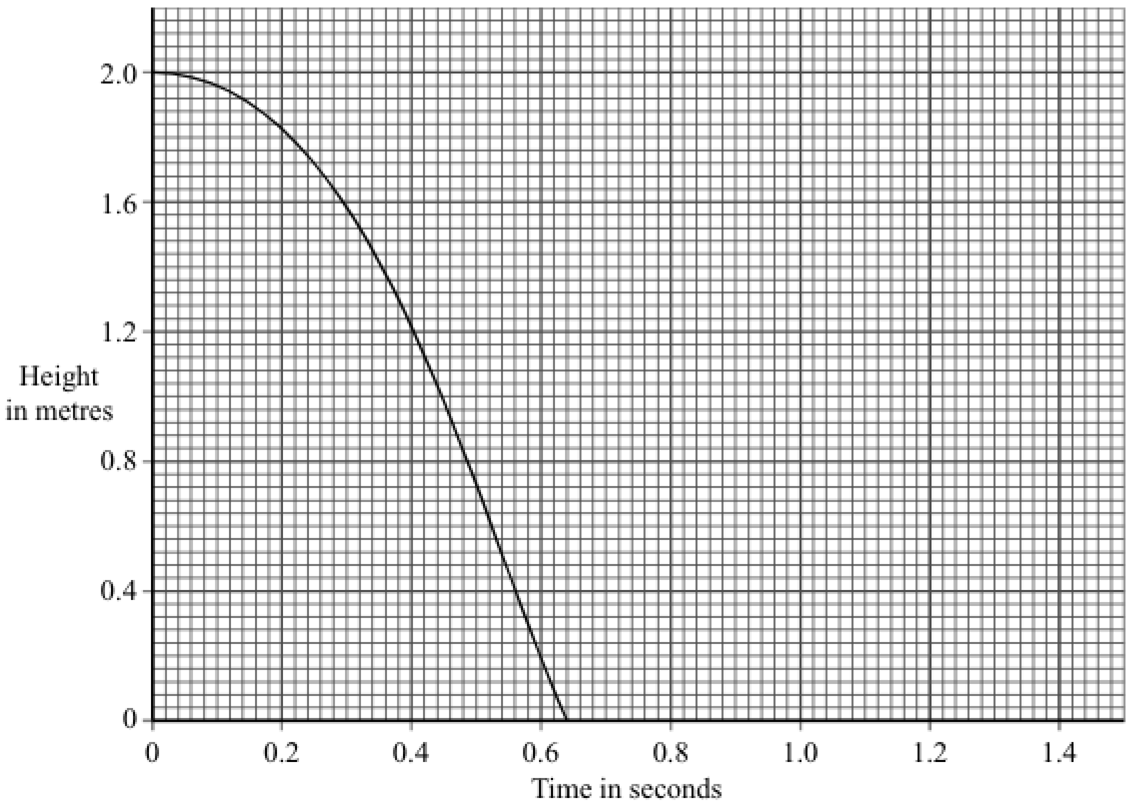
(d) Complete the following sentence by writing in the missing word.

The velocity of a car is its speed in a particular ________________________

(1)

(Total 13 marks)

44 A bouncy ball is dropped vertically from a height of 2.00 m onto the floor. The graph shows the height of the ball above the floor at different times during its fall until it hits the floor after 0.64 s.



(a) What is the average speed of the ball over the first 0.64 s? Show clearly how you work out your answer.

____

____

Average speed = ____________________ m/s

(1)

(b) After it hits the floor the ball bounces back to a height of 1.25 m. It reaches this height 1. 16 s after it was dropped. Plot this point on the grid above and sketch a graph to show the height of the ball above the floor between 0. 64 s and 1.16 s.

(3)

(c) (i) The ball bounces on the floor 0.64 s after being dropped. How long after being dropped will it be before it bounces a second time?

____

____

(1)

(ii) What distance will the ball travel between its first and second bounce?

____

____

(1)

(d) The ball was held stationary before being dropped. On the graph and your sketch mark **two** other points $\mathbf{X_1}$ and $\mathbf{X_2}$, where the ball is stationary, and in each case explain why the ball is not moving.

$\mathbf{X_1}$ ____

____

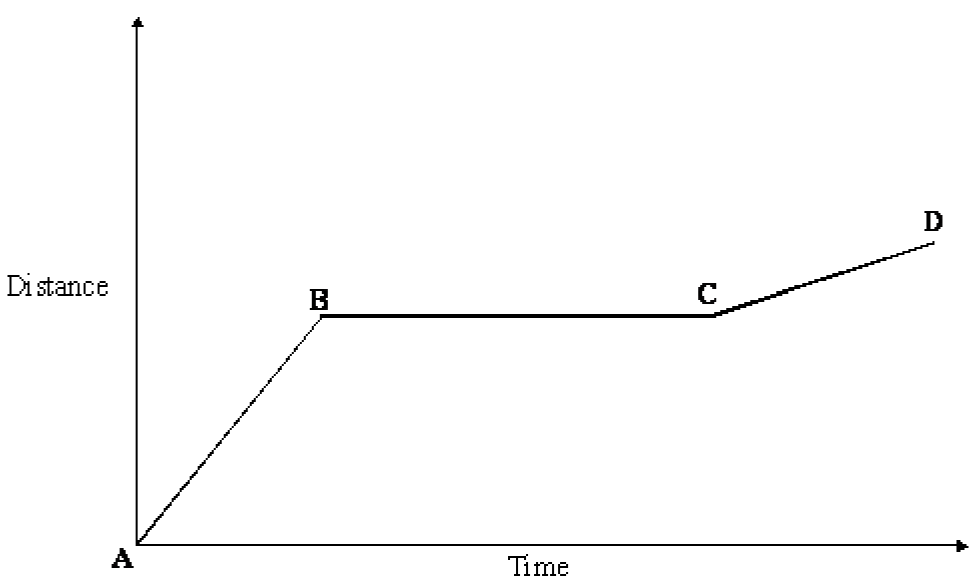
$\mathbf{X_2}$ ____

____

(2)

(Total 8 marks)

45 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)

46 Mira and Susan are rock climbing. They are using a nylon climbing rope. Mira has fastened herself to the rock face and to one end of the rope. The other end of the rope is fastened to Susan. This means that, if Susan falls, the rope will hold her. Susan weighs 540 N.

(a) (i) Use the words *distance*, *force* and *work* to write an equation which shows the relationship between them

____

(1)

(ii) What vertical distance up the rock face does Susan climb when she does 2000 J of work against gravity? Show your working and give your answer to the nearest 0.1 m.

____

____

Distance = ____________________ metres

(2)

(iii) How much gravitational energy will Susan gain when she does 2000 J of work against gravity?

____

(1)

(b) The climbers dislodge a 3 kg stone which falls down the rock face.

What is the speed of the stone when its kinetic energy is 600 J?

kinetic energy = $\frac{1}{2}$ mass × speed^2

Show clearly how you get to your answer and give the unit.

____

____

____

Speed = ______________________________

(3)

(c) The climbing rope is made of nylon. Nylon is very strong. Another advantage is that it stretches. This means that, if Susan falls, it transfers some of her kinetic energy to elastic (or strain) energy at the end of the fall.

Explain, in terms of *force* and *deceleration*, what would happen if Susan fell and the climbing rope did **not** transfer any of her kinetic energy to elastic energy.

____

____

____

____

____

____

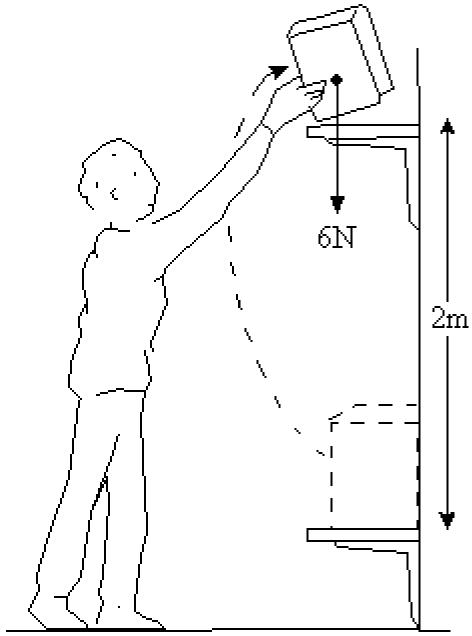
(3)

(Total 10 marks)

47

A book weighs 6 newtons.

A librarian picks up the book from one shelf and puts it on a shelf 2 metres higher.



(a) Calculate the work done on the book. [Show your working].

____

____

____

(3)

(b) The next person to take the book from the shelf accidentally drops it.

The book accelerates at 9.8m/s².

Use this information to calculate the mass of the book. [Show your working].

____

____

____

Answer _________________ kg.

(3)

(c) If the book was dropped from an aeroplane high in the sky, it would accelerate to begin with. Eventually it would fall at a steady speed.

Explain, in as much detail as you can, why this happens.

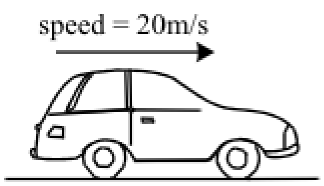
___

___

___

(3)
(Total 9 marks)

48 A car travels along a level road at 20 metres per second.



(a) Calculate the distance travelled by the car in 4 seconds.

(Show your working.)

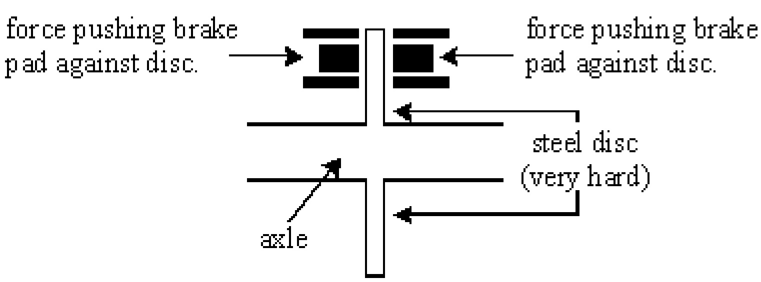
___

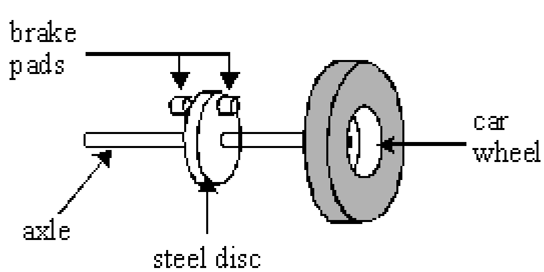
___

___

(3)

(b) When the brake pedal of the car is pushed, brake pads press against very hard steel discs.





The force of friction between the brake pads and the steel discs gradually stops the car.

What **two** effects does using the brakes have on the **brake pads** and **wheel discs**?

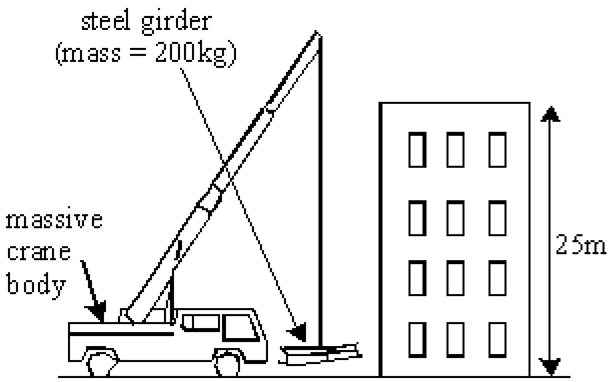
1. ____

2. ____

(3)

(Total 6 marks)

49 A crane is used to lift a steel girder to the top of a high building.



When it is lifted by the crane:

- the girder accelerates from rest to a speed of 0.6 m/s in the first 3 seconds;
- it then rises at a steady speed.

(a) Calculate the **acceleration** of the girder.

(Show your working.)

____

____

____

____

(3)

(b) (i) What is the **weight** of the steel girder?

Answer ______________________ N

(1)

(ii) Calculate the **power** of the crane motor as it lifts the girder at a steady speed of 0.6 m/s.

(*Show your working. You can ignore the weight of the cable and hook which is small compared to the weight of the girder.*)

____

____

____

Answer ______________________ W

(2)

(c) A new motor is fitted to the crane. This motor accelerates the girder at 0.3 m/s^2.

Calculate the **force** which the crane applies to the girder to produce this acceleration.

(Show your working.)

____

____

____

Answer ______________________ N

(3)

(Total 9 marks)

50 When a gun is fired, a very large force acts on the bullet for a very short time.

The change in momentum of the bullet is given by the following relationship:

force (N) × time(s) = change in momentum (kg m/s)

(a) An average force of 4000 newton acts for 0.01 seconds on a bullet of mass 50g.

Calculate the speed of the bullet. (*Show your working*.)

____

____

____

Answer ______________________ m/s

(4)

(b) The bullet is fired horizontally. In the short time it takes for the bullet to reach its target, its horizontal speed has fallen to 80% of its initial speed.

(i) Explain why the speed of the bullet decreases so quickly.

____

____

(2)

(ii) Calculate the percentage of its original kinetic energy the bullet still has when it reaches its target.

(Show your working.)

____

____

____

____

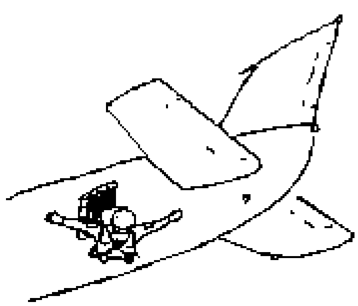
(4)

(Total 10 marks)

51 A sky-diver steps out of an aeroplane.

After 10 seconds she is falling at a steady speed of 50m/s.

She then opens her parachute.



After another 5 seconds she is once again falling at a steady speed.

This speed is now only 10m/s.

(a) Calculate the sky-diver’s average acceleration during the time from when she opens her parachute until she reaches her slower steady speed. (Show your working.)

____

____

____

(3)

(b) Explain, as fully as you can:

(i) why the sky-diver eventually reaches a steady speed (with or without her parachute).

___

___

___

___

(3)

(ii) why the sky-diver's steady speed is lower when her parachute is open.

___

(1)

(c) The sky-diver and her equipment have a total mass of 75kg. Calculate the gravitational force acting on this mass. (Show your working.)

___

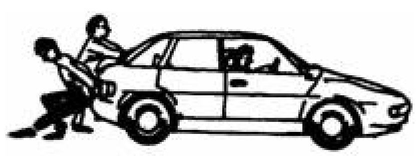
___

Answer ______________ N

(1)

(Total 8 marks)

52 A man's car will not start, so two friends help him by pushing it.



Mass of car = 800 kg

By pushing as hard as they can for 12 seconds they make the car reach a speed of 3 metres per second.

(a) Calculate the acceleration they give to the car.

___

___

___ Answer ________ m/s^2

(2)

(b) Whilst pushing the car the two friends together do a total of 2400 joules of work. Calculate their total power.

____

____

____ Answer __________ watts

(2)

(c) Another motorist has the same problem. The two friends push his car along the same stretch of road with the same force as before.

It takes them 18 seconds to get the second car up to a speed of 3 metres per second.

What does this tell you about the mass of the second car?
(You can ignore forces of friction.)

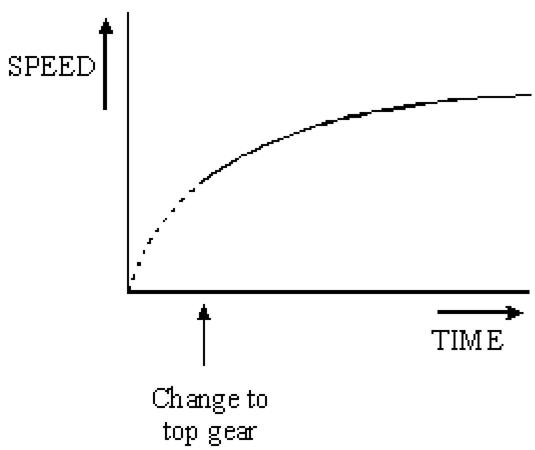
____

____

(2)

(d) On a flat stretch of a motorway a lorry driver changes into top gear. He then makes the lorry go as fast as he can.

The graph shows what happens to the speed of the lorry.



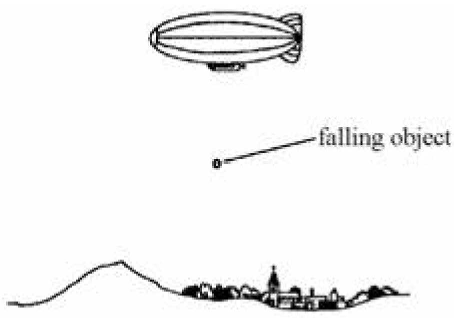
Explain why the speed of the lorry increases at first but then levels out.

____

____

(3)
(Total 9 marks)

53 A small object falls out of a balloon.



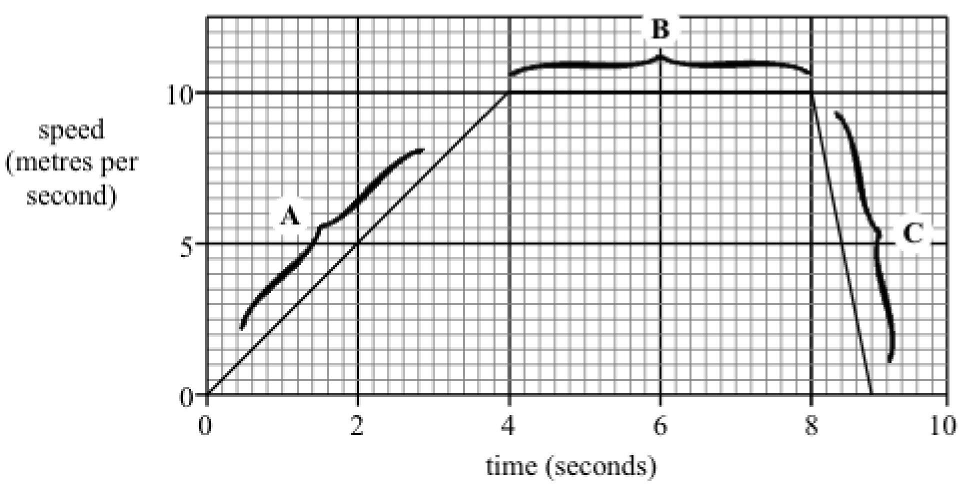
Choose words from the list to complete the sentences below.

friction	**gravity**	**air pressure**
accelerates	**falls at a steady speed**	**slows down**

- The weight of an object is the force of ______________________ which acts on it.
- When you drop something, first of all it ________________________ .
- The faster it falls, the bigger the force of _____________________ which acts on it.
- Eventually the object _______________________ .

(Total 4 marks)

54 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.)

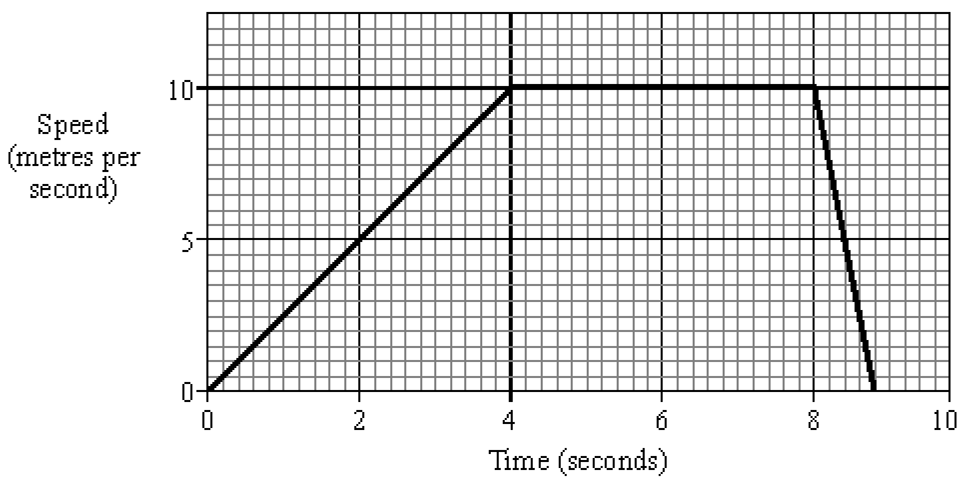
____

____

____

(3)
(Total 6 marks)

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



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

____

____

____

(3)

(b) How far does the runner travel during the first four seconds?
(Show your working.)

____

____

____

(3)

(c) At the finish, a thick wall of rubber foam slows the runner down at a rate of 25 m/s^2.
The runner has a mass of 75kg.
Calculate the average force of the rubber foam on the runner.
(Show your working.)

____

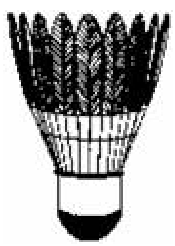
____

____

Answer ______________ newtons (N)

(2)
(Total 8 marks)

56 The diagram shows a shuttlecock that is used for playing badminton.



The shuttlecock weighs very little.
When you drop it from a height of a few metres, it accelerates at first but soon reaches a steady speed.

Explain, as fully as you can:

(a) why the shuttlecock accelerates at first,

____

____

____

(2)

(b) why the shuttlecock reaches a steady speed.

___

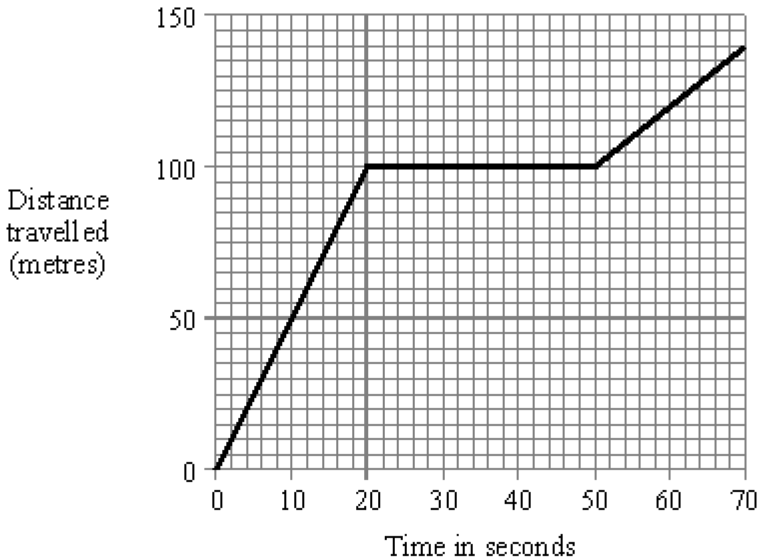
___

___

___

(3)
(Total 5 marks)

57 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)