Chapter 10 Forces and Motion

Name: _____

Class: _____

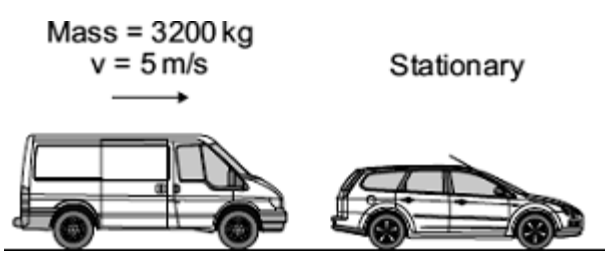
Date: _____

Time: **282 minutes**

Marks: **282 marks**

Comments:

1 (a) A van has a mass of 3200 kg. The diagram shows the van just before and just after it collides with the back of a car.



Before collision

After collision

Just before the collision, the van was moving at 5 m/s and the car was stationary.

(i) Use the equation in the box to calculate the momentum of the van just before the collision.

momentum = mass × velocity

Show clearly how you work out your answer.

.....

.....

Momentum = ... kg m/s

(2)

(ii) The collision makes the van and car join together.

What is the total momentum of the van and the car just after the collision?

Momentum = ... kg m/s

(1)

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

The momentum of the car before the collision is

more than
the same as
less than

the

momentum of the car after the collision.

(1)

(b) A seat belt is one of the safety features of a car.

In a collision, wearing a seat belt reduces the risk of injury.

Use words or phrases from the box to complete the following sentences.

decreases	stays the same	increases

In a collision, the seat belt stretches. The time it takes for the person held by the seat belt to lose momentum compared to a person not wearing a seat belt,

..... .

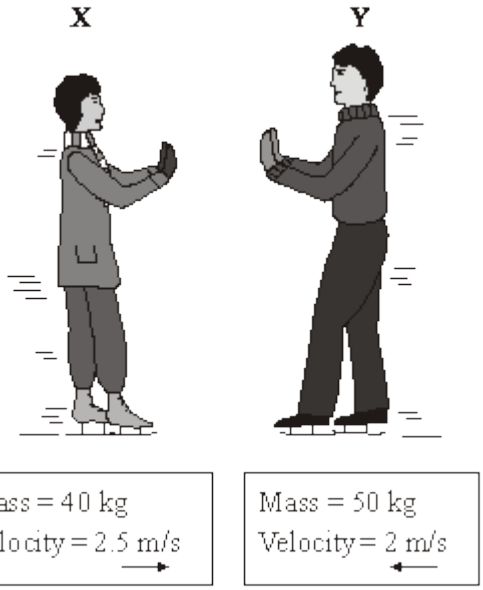
The force on the person's body ..... and so reduces the risk of injury.

(2)

(Total 6 marks)

2 The picture shows two children, **X** and **Y**, skating towards each other at an ice rink.

The children collide with each other, fall over and stop.



(a) Before the collision the children had different amounts of kinetic energy.

(i) What are the **two** factors that determine the kinetic energy of the children?

1 .....

2 .....

(2)

(ii) What was the total kinetic energy of the children after they had fallen over and stopped?

.....

(1)

(b) The total momentum of the children before and after the collision is zero.

(i) Use the equation in the box and the data given in the diagram to calculate the momentum of child Y before the collision.

momentum = mass × velocity

Show clearly how you work out your answer.

.....

.....

Momentum = ... kg m/s

(2)

(ii) Complete the following sentence using one of the words in the box.

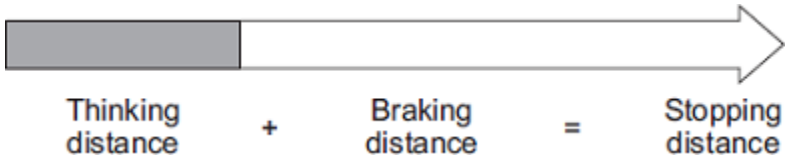
conserved	decreased	increased

The total momentum of the two children was .....

(1)

(Total 6 marks)

3 The diagram shows how the thinking distance and braking distance of a car add together to give the stopping distance of the car.



(a) Use words from the box to complete the sentence.

distance	energy	force	time

The stopping distance is found by adding the distance the car travels during the driver's reaction ..... and the distance the car travels under the braking ..... .

(2)

(b) Which **one** of the following would **not** increase the thinking distance?

Tick (✓) **one** box.

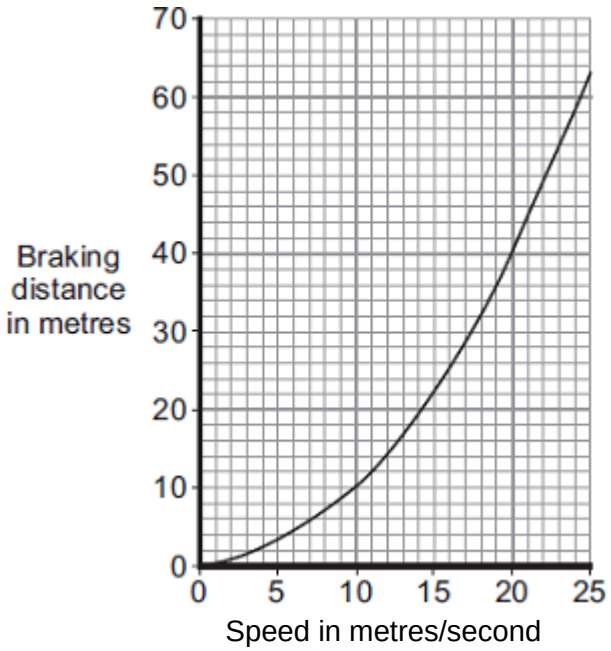
The car driver being tired. ☐

The car tyres being badly worn. ☐

The car being driven faster. ☐

(1)

(c) The graph shows how the braking distance of a car changes with the speed of the car. The force applied to the car brakes does not change.



(i) What conclusion about braking distance can be made from the graph?

.....

.....

.....

.....

(2)

(ii) The graph is for a car driven on a dry road.

Draw a line on the graph to show what is likely to happen to the braking distance at different speeds if the same car was driven on an icy road.

(1)

(d) A local council has reduced the speed limit from 30 miles per hour to 20 miles per hour on a few roads. The reason for reducing the speed limit was to reduce the number of accidents.

(i) A local newspaper reported that a councillor said:

"It will be much safer because drivers can react much faster when driving at 20 miles per hour than when driving at 30 miles per hour."

This statement is wrong. Why?

.....

.....

(1)

(ii) The local council must decide whether to introduce the lower speed limit on a lot more roads.

What evidence should the local council collect to help make this decision?

.....

.....

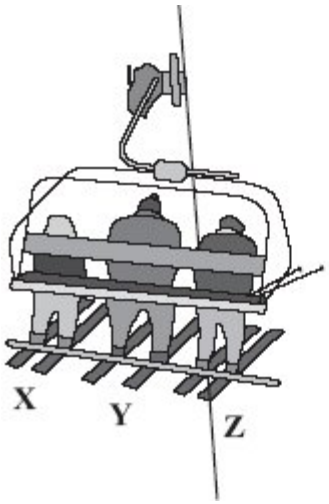
.....

.....

(2)

(Total 9 marks)

4 (a) The diagram shows three skiers, **X**, **Y** and **Z**, on a moving chairlift.
The mass of each skier is given in the table.



Skier	Mass in kg
X	65
Y	90
Z	80

Which **one** of the skiers, **X**, **Y** or **Z**, has the most momentum?

.....

Give the reason for your answer.

.....

.....

(2)

(b) At one point in the journey, the chairlift accelerates to a higher speed.

What happens to the momentum of the three skiers as the chairlift accelerates?

.....

(1)

(Total 3 marks)

5 Some students designed and built an electric-powered go-kart.
The go-kart is shown below.

(a) Suggest **two** changes that could be made to the design of the go-kart to increase its top speed.

1 .....

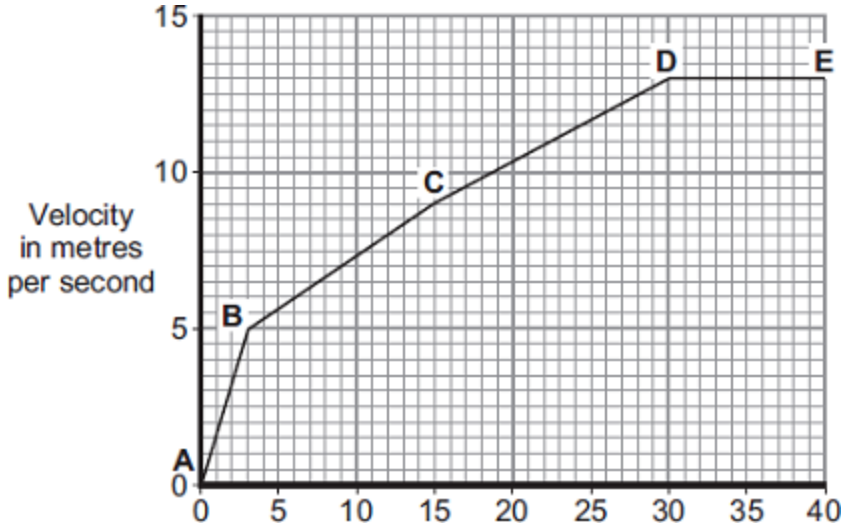
.....

2 .....

.....

(2)

(b) A go-kart with a new design is entered into a race.
The velocity-time graph for the go-kart, during the first 40 seconds of the race, is shown below.



(i) Between which **two** points did the go-kart have the greatest acceleration?

Tick (✓) **one** box.

A–B ☐

B–C ☐

C–D ☐

Give a reason for your answer.

.....

.....

(2)

(ii) The go-kart travels at a speed of 13 m/s between points **D** and **E**.
The total mass of the go-kart and driver is 140 kg.

Calculate the momentum of the go-kart and driver between points **D** and **E**.

Use the correct equation from the Physics Equations Sheet.

.....

.....

Momentum = ... kg m/s

(2)

(Total 6 marks)

6 The diagram shows a supermarket worker stacking jars of coffee onto a shelf.

(a) The mass of each jar of coffee is 0.4 kg.

Calculate the weight of each jar of coffee.

gravitational field strength = 10 N/kg

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

.....

Weight = ... N

(2)

(b) The distance between the floor and the middle shelf is 1.2 m.

Calculate the work done to lift one jar of coffee from the floor onto the shelf.

Write down the equation you use, and then show clearly how you work out your answer and give the unit.

.....

.....

.....

.....

.....

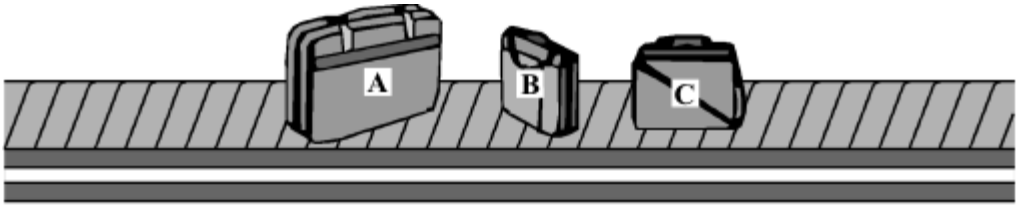
.....

Work done = ...

(3)

(Total 5 marks)

7 The picture shows luggage which has been loaded onto a conveyor belt.



Each piece of luggage has a different mass.

Mass of **A** = 22 kg mass of **B** = l2 kg mass of **C** = 15 kg

(a) (i) What is the momentum of the luggage before the conveyor belt starts to move?

.....

Give a reason for your answer.

.....

.....

(2)

(ii) When the conveyor belt is switched on the luggage moves with a constant speed. Which piece of luggage **A**, **B** or **C** has the most momentum?

.....

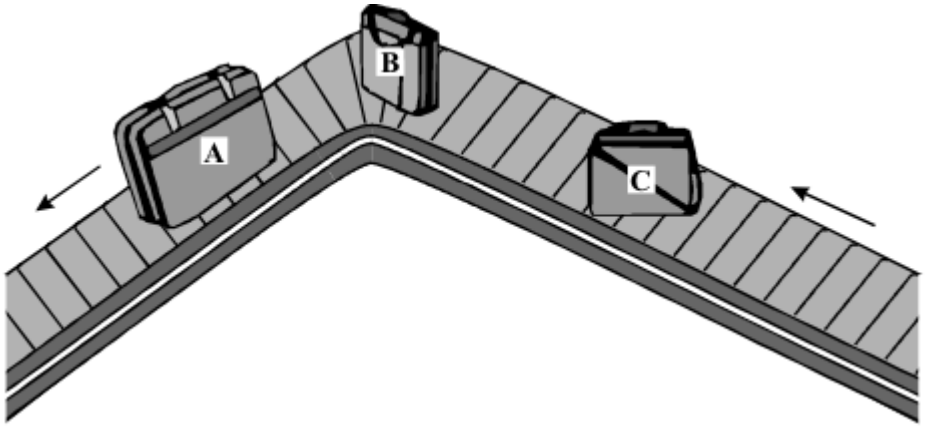
Give a reason for your answer.

.....

.....

(2)

(iii) At one point the conveyor belt turns left. The luggage on the belt continues to move at a constant speed.



Does the momentum of the luggage change as it turns left with the conveyor belt?

.....

Give a reason for your answer.

.....

.....

(2)

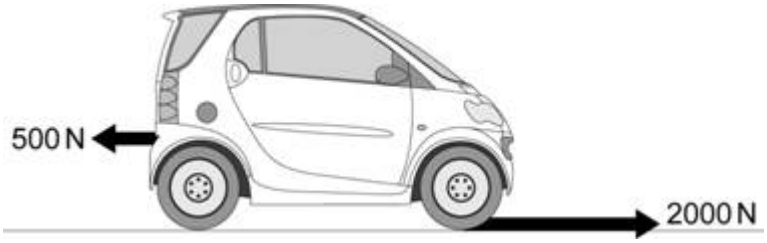
(b) Draw a circle around the unit which can be used to measure momentum.

J/s kg m/s Nm

(1)

(Total 7 marks)

8 (a) The diagram shows the horizontal forces acting on a car travelling along a straight road.



(i) Calculate the size of the resultant force acting on the car.

Show clearly how you work out your answer.

.....

.....

Resultant force = ... N

(2)

(ii) Describe the motion of the car when the forces shown in the diagram act on it.

.....

.....

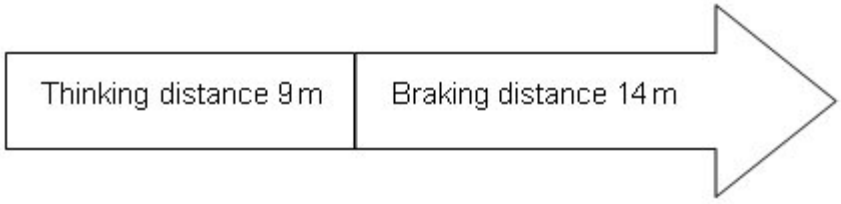
.....

.....

(2)

(b) A car driver makes an emergency stop.

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



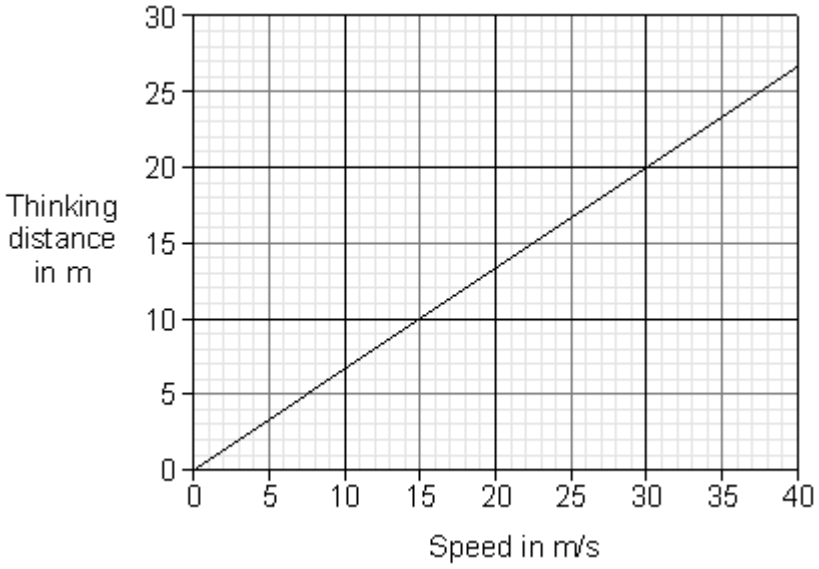
(i) Calculate the total stopping distance of the car.

.....

Stopping distance = ... m

(1)

(ii) The graph shows that speed affects thinking distance.



Use the graph to find the thinking distance for a car driven at 30 m/s.

Thinking distance = ... m

(1)

(iii) Give **one** further factor that will affect the thinking distance.

.....

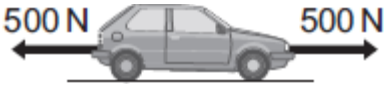
(1)

(Total 7 marks)

9 (a) The diagrams, **A**, **B** and **C**, show the horizontal forces acting on a **moving** car.

Draw a line to link each diagram to the description of the car's motion at the moment when the forces act.

Draw only **three** lines.



A

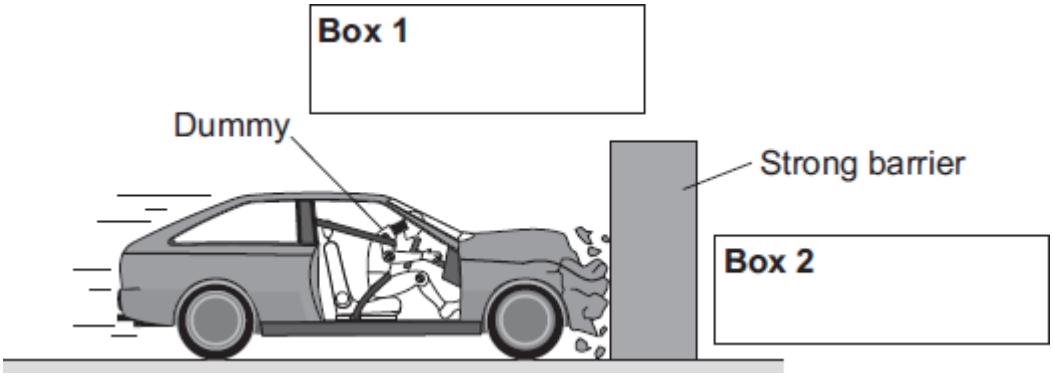
B

C

stationary
constant speed
slowing down
accelerating forwards

(3)

(b) The front crumple zone of a car is tested at a road traffic laboratory. This is done by using a remote control device to drive the car into a strong barrier. Electronic sensors are attached to a dummy inside the car.



(i) Draw an arrow in **Box 1** to show the direction of the force that the car exerts on the barrier.

(1)

(ii) Draw an arrow in **Box 2** to show the direction of the force that the barrier exerts on the car.

(1)

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

The car exerts a force of 5000 N on the barrier. The barrier does not move. The force exerted by the barrier on the car will be

more than
equal to
less than

5000 N.

(1)

(iv) Which **one** of the following gives the most likely reason for attaching electronic sensors to the dummy?

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

To measure the speed of the car just before the impact. ☐

To measure the forces exerted on the dummy during the impact. ☐

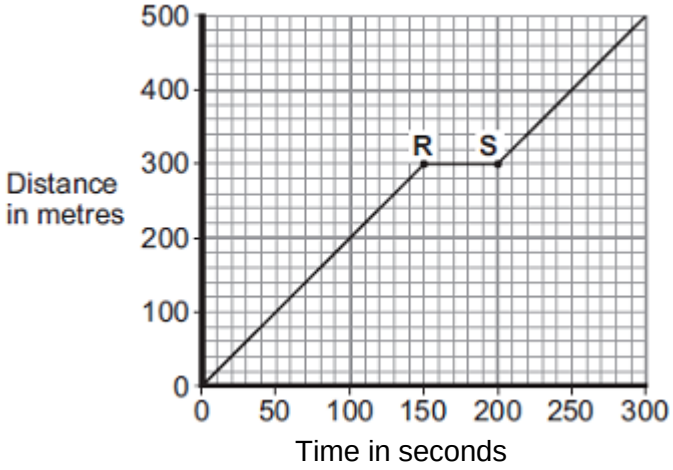
To measure the distance the car travels during the impact. ☐

(1)

(Total 7 marks)

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

Figure 1



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

Tick (✓) **one** box.

Not moving ☐

Moving at constant speed ☐

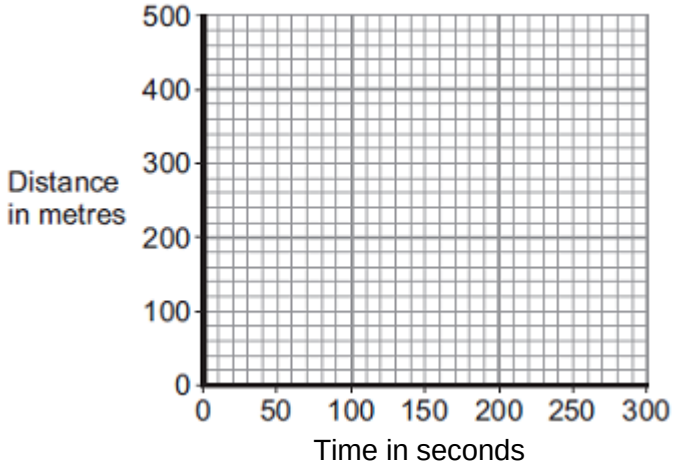
Moving with increasing speed ☐

(1)

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

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

Figure 2



(1)

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

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

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

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

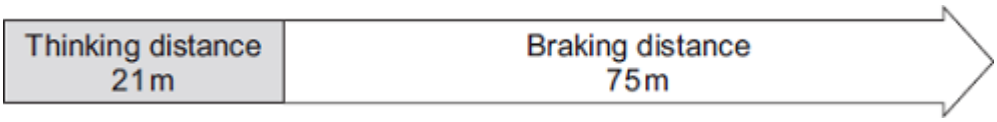
Resultant force = ... N

(2)

(Total 4 marks)

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

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



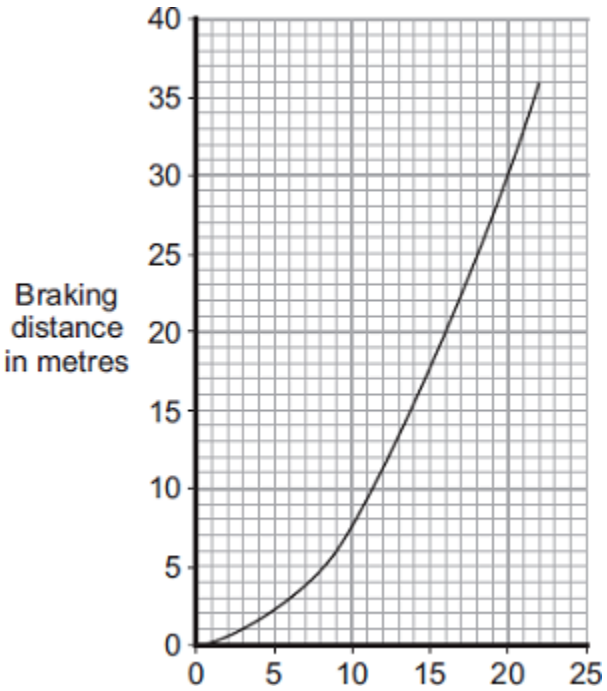
Calculate the total stopping distance of the car.

.....

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 **one** of the following would also increase the braking distance of the car?

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

Rain on the road ☐

The driver having drunk alcohol ☐

The driver having taken drugs ☐

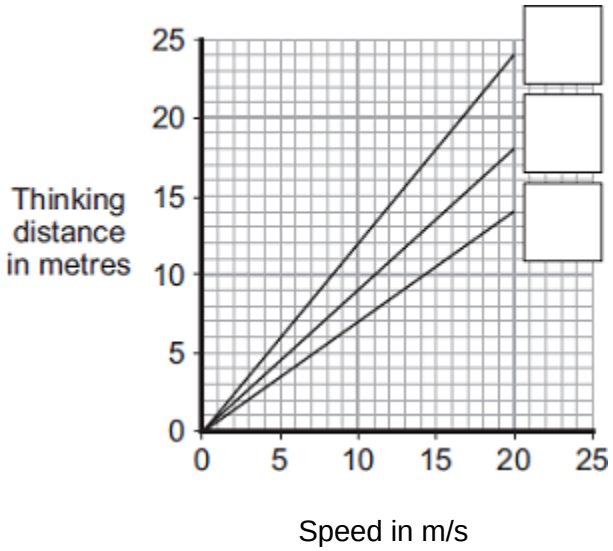
(1)

(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 second
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.

.....

.....

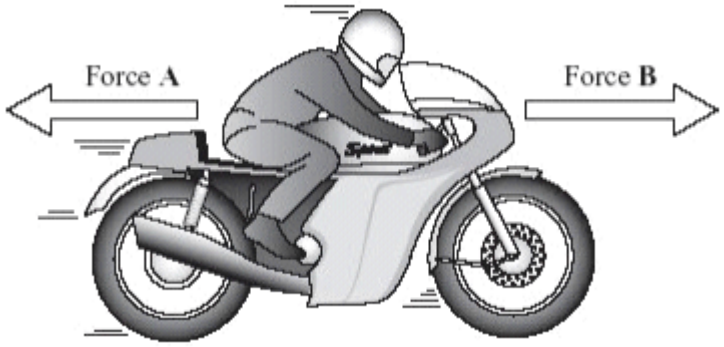
.....

.....

(2)

(Total 8 marks)

12 (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**.

.....

.....

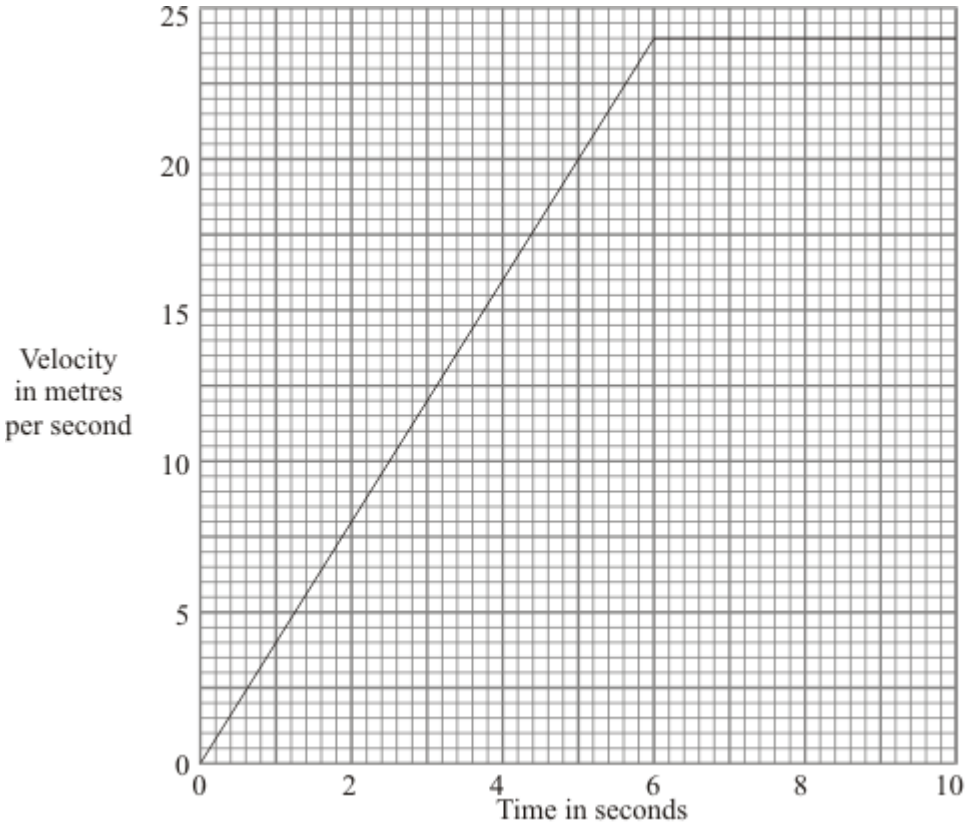
(2)

(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 .....

.....

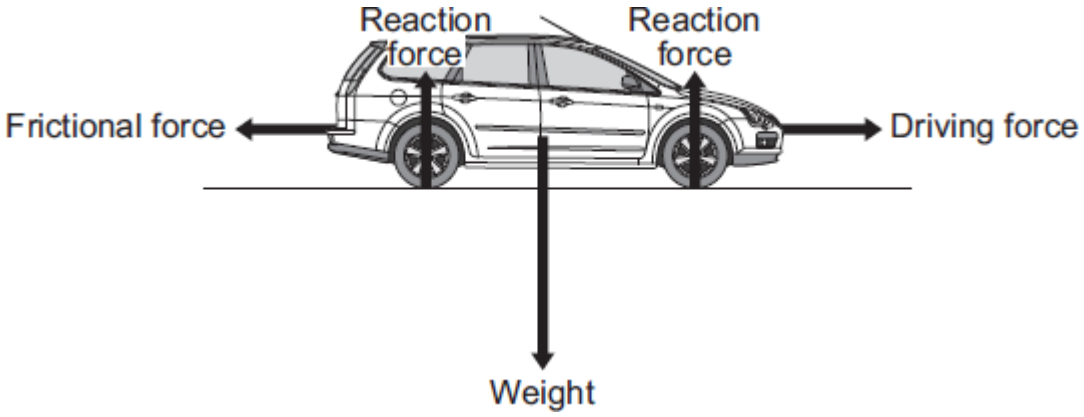
3 .....

.....

(3)

(Total 13 marks)

13 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.



(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.

.....

.....

.....

.....

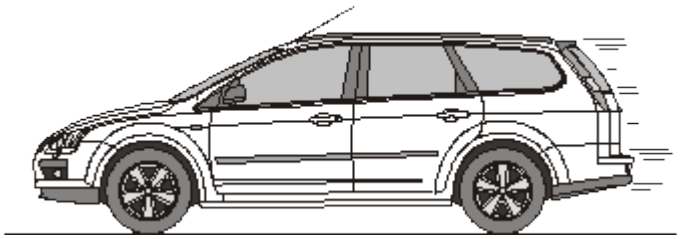
.....

.....

(3)

(Total 6 marks)

14 (a) The diagram shows a car travelling at a speed of 12 m/s along a straight road.



(i) Use the equation in the box to calculate the momentum of the car.

momentum = mass × velocity

Mass of the car = 900 kg

Show clearly how you work out your answer.

.....

.....

.....

.....

Momentum = ... kg m/s

(2)

(ii) Momentum has direction.

Draw an arrow on the diagram to show the direction of the car's momentum.

(1)

(b) The car stops at a set of traffic lights.

How much momentum does the car have when it is stopped at the traffic lights?

.....

Give a reason for your answer.

.....

.....

.....

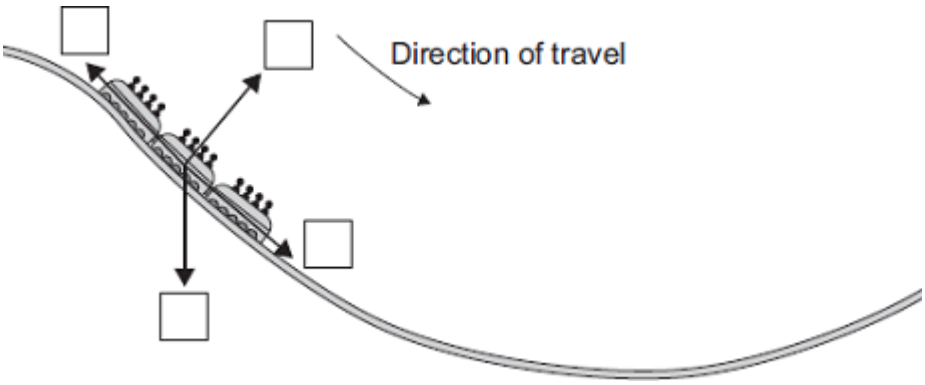
.....

(2)

(Total 5 marks)

15 The diagram shows the passenger train on part of a rollercoaster ride.

(a) Which arrow shows the direction of the resultant force acting on the passenger train?
Put a tick (✓) in the box next to your choice.



(1)

(b) For part of the ride, the maximum gravitational field strength acting on the passengers seems 3 times bigger than normal.

Normal gravitational field strength = 10 N/kg

(i) Calculate the maximum gravitational field strength that seems to act on the passengers during the ride.

.....

.....

Maximum gravitational field strength = ... N/kg

(1)

(ii) One of the passengers has a mass of 75 kg.

Use the equation in the box to calculate the maximum weight this passenger seems to have during the ride.

weight = mass × gravitational field strength

Show clearly how you work out your answer.

.....

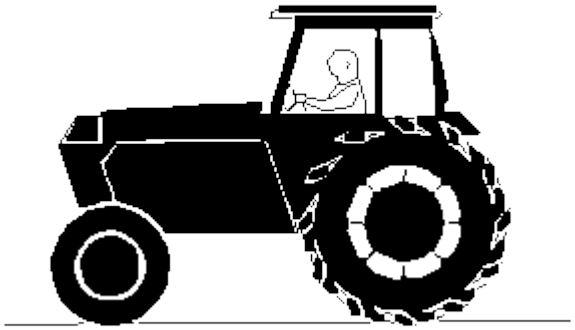
.....

Maximum weight = ... N

(2)

(Total 4 marks)

16 (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?

.....

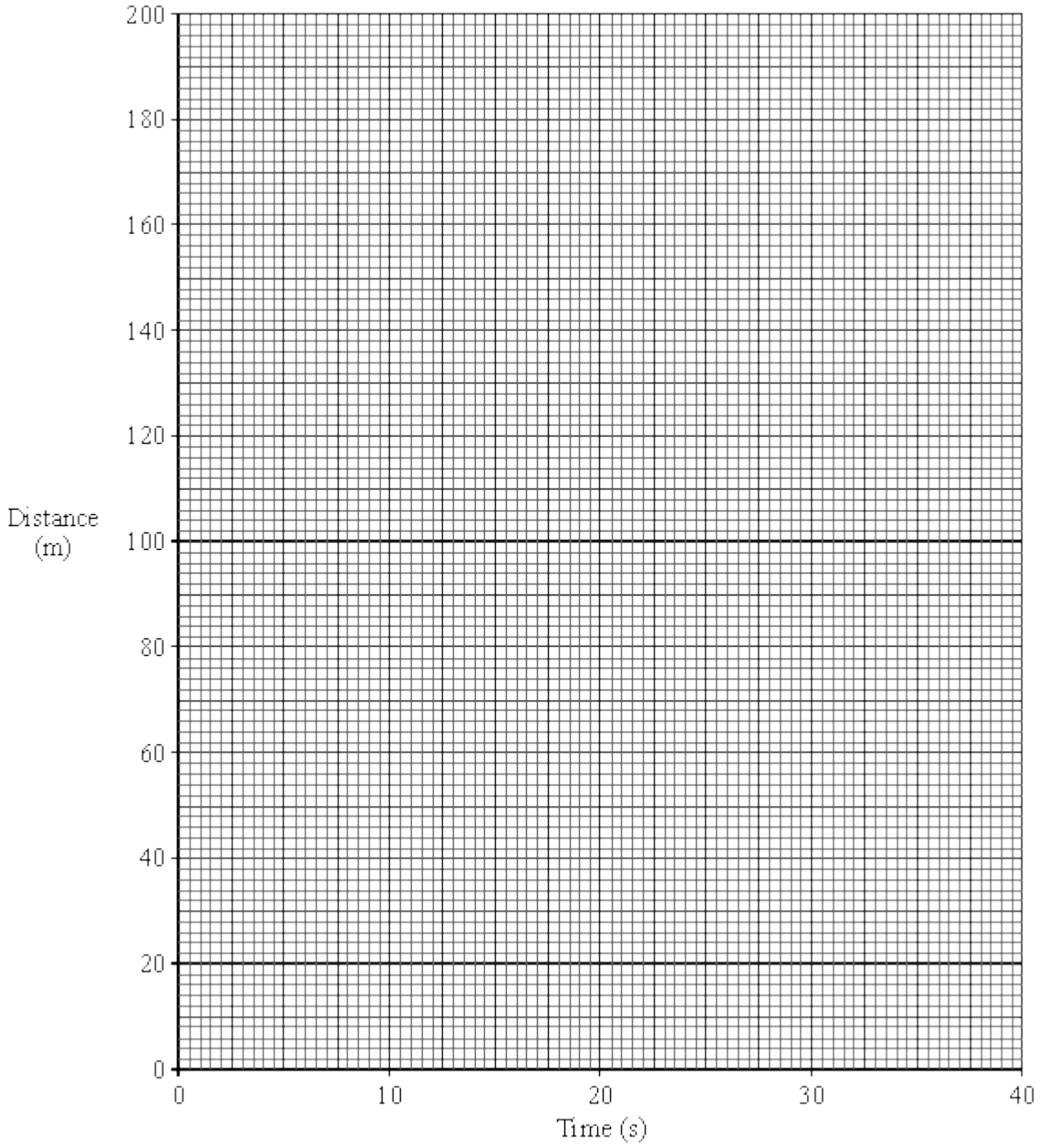
.....

(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.

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.



(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/s²

(3)

(Total 15 marks)

17 (a) The picture shows two teenagers riding identical skateboards.
The skateboards are moving at the same speed and the teenagers have the same mass.

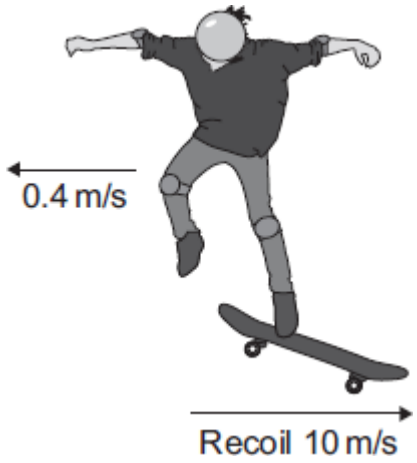
Why do the teenagers **not** have the same momentum?

.....

.....

(1)

(b) One of the skateboards slows down and stops. The teenager then jumps off the skateboard, causing it to recoil and move in the opposite direction.



The momentum of the teenager and skateboard is conserved.

(i) What is meant by 'momentum being conserved'?

.....

.....

(1)

(ii) The teenager, of mass 55 kg, jumps off the skateboard at 0.4 m/s causing the skateboard to recoil at 10 m/s.

Use the equation in the box to calculate the mass of the skateboard.

momentum = mass × velocity

.....

.....

.....

Mass = ... kg

(3)

(c) Once the skateboard starts to recoil, it soon slows down and its kinetic energy decreases.

Explain why.

.....

.....

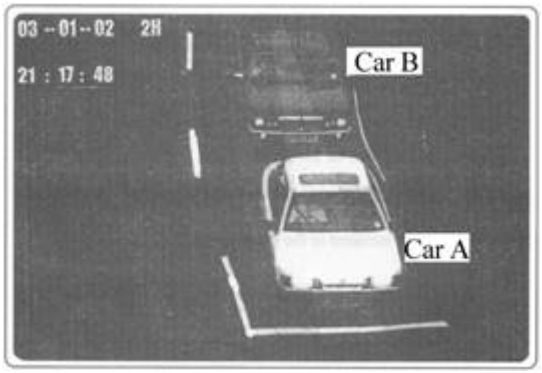
.....

.....

(2)

(Total 7 marks)

18 The roads were very icy. An accident was recorded by a security camera.



Car **A** was waiting at a road junction. Car **B**, travelling at 10 m/s, went into the back of car **A**. This reduced car **B**'s speed to 4 m/s and caused car **A** to move forward.

The total mass of car **A** was 1200 kg and the total mass of car **B** was 1500 kg.

(i) Write down the equation, in words, which you need to use to calculate momentum.

.....

(1)

(ii) Calculate the change in momentum of car **B** in this accident.

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

.....

.....

Change in momentum = ...

(3)

(iii) Use your knowledge of the conservation of momentum to calculate the speed, in m/s, of car **A** when it was moved forward in this accident.

Show clearly how you work out your final answer.

.....

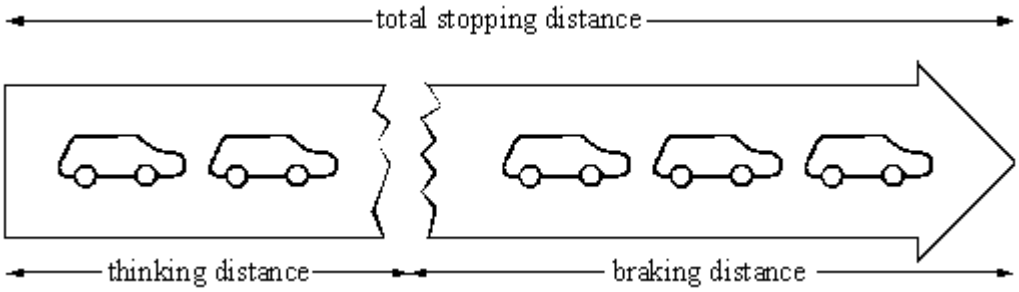
.....

Speed = ... m/s

(3)

(Total 7 marks)

19 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.

.....

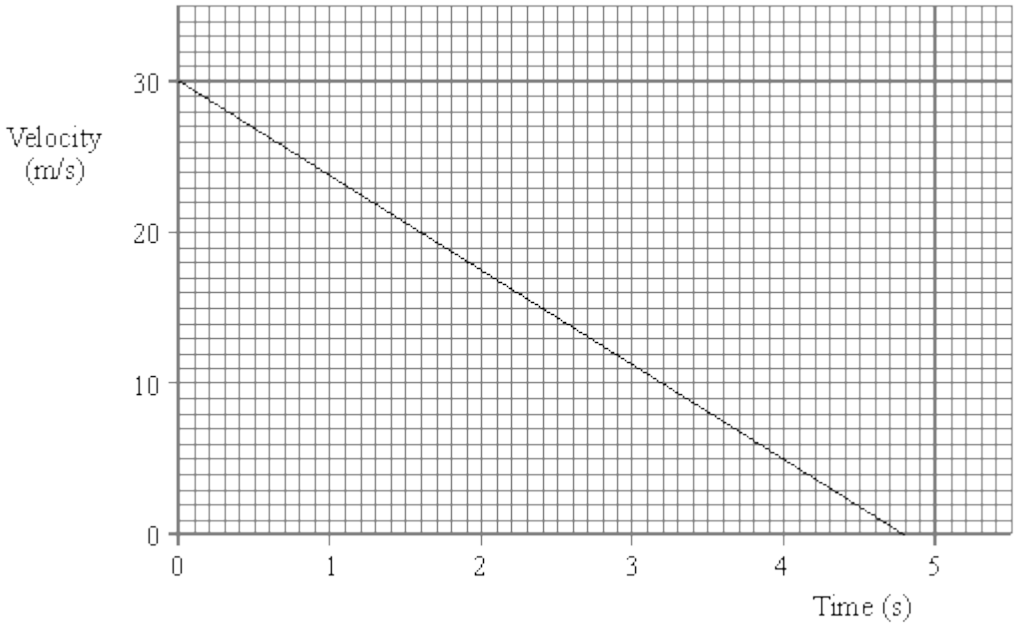
.....

.....

.....

(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/s²

(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)

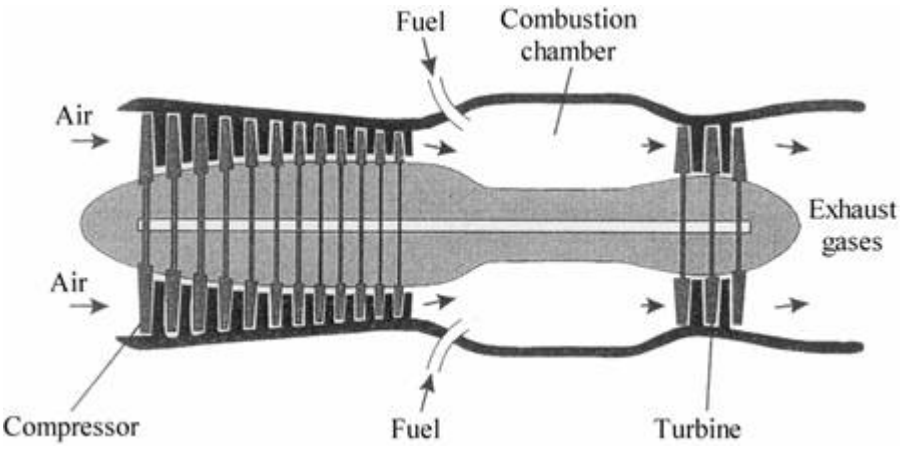
20 (a) What is the principle of conservation of momentum?

.....

.....

(2)

(b) The diagram shows a simplified aircraft jet engine.



Adapted from GCSE Physics by Tom Duncan. John Murray (Publishers) Ltd.

(i) What is the function of the turbine?

.....

.....

(1)

(ii) Explain how the engine produces a forward thrust.

.....

.....

.....

.....

.....

.....

.....

(4)

(c) During flight, air enters the engine at 175 m/s and leaves at 475 m/s. A forward thrust of 105 kN is produced.

Use the following equation to calculate the mass of air passing through the engine every second. (Ignore the mass of the burned fuel.)

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

.....

.....

.....

Mass of air = ... kg

(2)

(Total 9 marks)

21 (a) In any collision, the total momentum of the colliding objects is usually conserved.

(i) What is meant by the term 'momentum is conserved'?

.....

.....

(1)

(ii) In a collision, momentum is **not** always conserved.

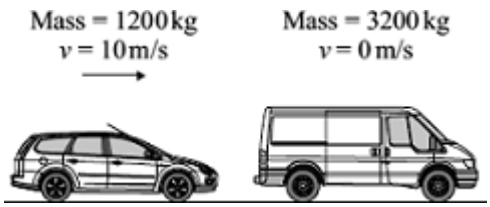
Why?

.....

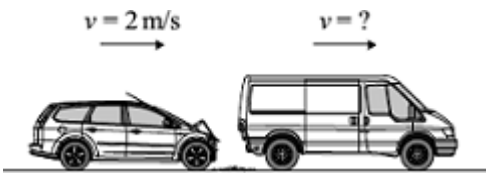
.....

(1)

(b) The diagram shows a car and a van, just before and just after the car collided with the van.



Before collision



After collision

(i) Use the information in the diagram and the equation in the box to calculate the **change** in the momentum of the car.

momentum = mass × velocity

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

.....

.....

.....

.....

Change in momentum =.....

(3)

(ii) Use the idea of conservation of momentum to calculate the velocity of the van when it is pushed forward by the collision.

Show clearly how you work out your answer.

.....

.....

.....

Velocity =..... m/s forward

(2)

(Total 7 marks)

22 (a) How can the momentum of an object be calculated?

.....

.....

(2)

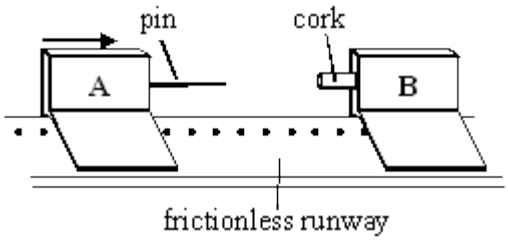
(b) In a collision momentum is always conserved. What does this mean?

.....

.....

(2)

(c) Two trolleys are placed on a frictionless runway as shown in the diagram below. Trolley A has a protruding pin, and trolley B is fitted with a piece of soft cork so that the trolleys will stick together after colliding.



Trolley A has a mass of 2 kg, and trolley B has a mass of 1 kg. Trolley B is stationary. Trolley A strikes trolley B at a speed of 6 m/s. Both trolleys then move to the right together.

(i) Calculate the speed at which trolleys A and B jointly move after the collision.

.....

.....

.....

.....

(4)

(ii) Calculate the change in kinetic energy which occurs during the collision.

.....

.....

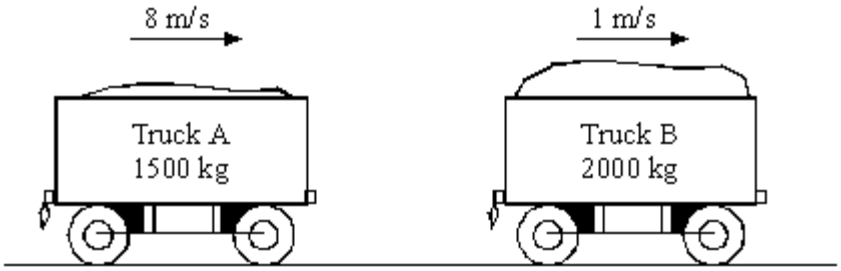
.....

.....

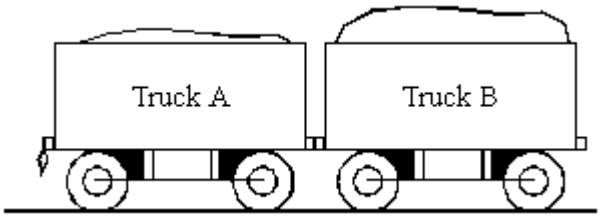
(4)

(Total 12 marks)

23 The drawing below shows two railway trucks A and B, moving in the same direction. Truck **A**, of mass 1500 kg, is initially moving at a speed of 8 m/s. Truck **B**, of mass 2000 kg, is initially moving at a speed of 1 m/s.



Truck A catches up and collides with truck B. The two trucks become coupled together as shown in the diagram.



(a) Calculate:

(i) the initial momentum of truck A.

.....

..... momentum ..... kg m/s

(ii) the initial momentum of truck B.

.....

..... momentum ..... kg m/s

(iii) the total momentum of the trucks before the collision.

.....

..... total momentum ..... kg m/s

(6)

(b) Calculate the speed of the coupled trucks after the collision.

.....

.....

.....

.....

(5)

(c) (i) How is the total kinetic energy of the trucks changed as a result of the collision? A calculated answer is not needed for full marks.

.....

(ii) State an energy transfer which accounts for part of the change in the total kinetic energy of the trucks during the collision.

.....

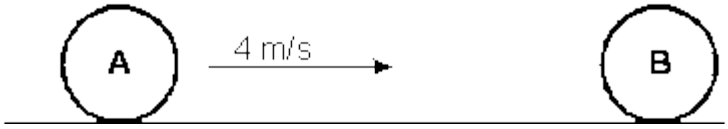
(iii) What would have been the effect on the change of total kinetic energy of the trucks if the collision had been more elastic?

.....

(3)

(Total 14 marks)

24 The diagram below shows two balls on the bowling green. Ball A is moving with a velocity of 4 m/s, and is about to collide with ball B which is stationary. Both balls have a mass of 1.5 kg.



After the collision both balls move to the right but the velocity of A is now 1 m/s.

(a) (i) Calculate the momentum of ball A just before the collision.

.....

Answer ..... kg m/s

(1)

(ii) What is the total momentum of balls A and B after the collision?

.....

.....

Answer ..... kg m/s

(1)

(iii) Calculate the momentum of ball A just after the collision.

.....

Answer ..... kg m/s

(1)

(iv) Calculate the momentum of ball B just after the collision.

.....

Answer ..... kg m/s

(1)

(v) Calculate the velocity of ball B just after the collision.

.....

Answer ..... m/s

(1)

(b) Calculate the loss of kinetic energy in the collision.

.....

.....

.....

.....

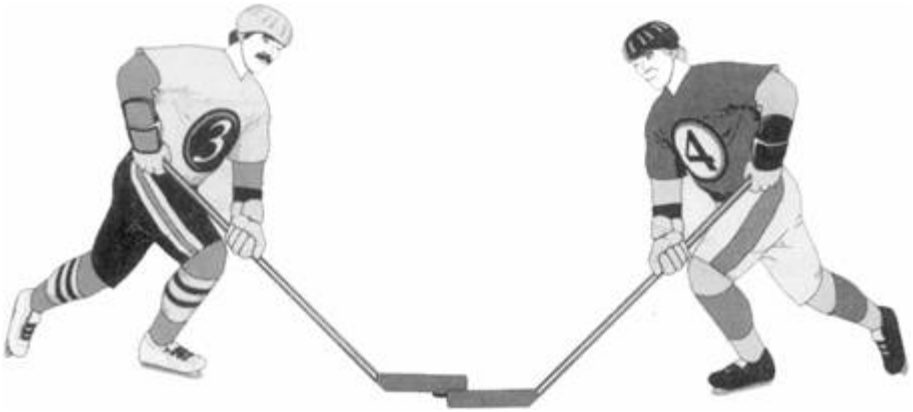
.....

Answer ..... J

(3)

(Total 8 marks)

25 (a) The picture shows two ice hockey players skating towards the puck. The players, travelling in opposite directions, collide, fall over and stop.



Player **3**

mass = 75 kg
speed = 4 m/s

Player **4**

(i) Use the following equation and the data given in the box to calculate the momentum of player number **3** before the collision. Show clearly how you work out your answer and give the unit.

momentum = mass × velocity

.....

.....

Momentum of player **3** = ...

(3)

(ii) What is the momentum of player **4** just before the collision?

.....

(1)

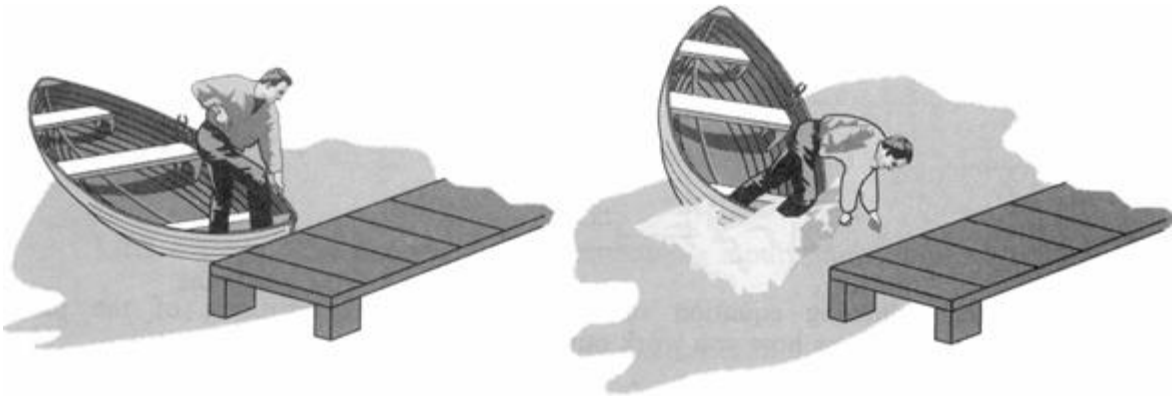
(iii) The collision between the two players is **not** *elastic*. What is meant by an *elastic* collision?

.....

.....

(1)

(b) The pictures show what happened when someone tried to jump from a stationary rowing boat to a jetty.



Use the idea of momentum to explain why this happened.

.....

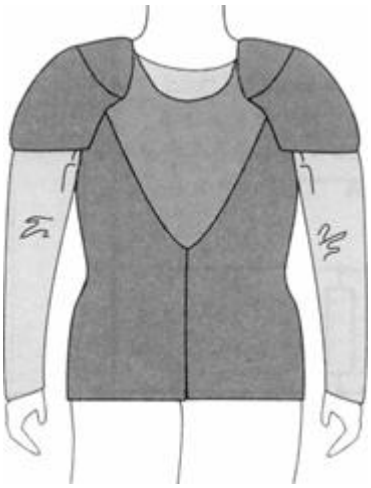
.....

.....

.....

(2)

(c) The diagram shows one type of padded body protector which may be worn by a horse rider.



If the rider falls off the horse, the body protector reduces the chance of the rider being injured. Use the idea of momentum to explain why.

.....

.....

.....

.....

.....

.....

(3)

(Total 10 marks)

26 (a) Complete the following sentence.

The momentum of a moving object has a magnitude, in kg m/s,

and a ..... .

(1)

(b) A car being driven at 9.0 m/s collides with the back of a stationary lorry.
The car slows down and stops in 0.20 seconds. The total mass of the car and driver is 1200 kg.

Use the equations in the box to calculate the average force exerted by the lorry on the car during the collision.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time take for the change}}$$

Show clearly how you work out your answer.

.....

.....

Force = ... N

(2)

(c) Within 0.04 s of the car hitting the back of the lorry, the car driver's airbag inflates.
The airbag deflates when it is hit by the driver's head.

Use the idea of momentum to explain why the airbag reduces the risk of the drive sustaining a serious head injury.

.....

.....

.....

.....

.....

.....

(3)

(Total 6 marks)

27 The diagram shows the horizontal forces acting on a car of mass 1200 kg.

(a) Calculate the acceleration of the car at the instant shown in the diagram.

Write down the equation you use, and then show clearly how you work out your answer and give the unit.

.....

.....

.....

.....

.....

.....

.....

.....

Acceleration = ...

(4)

(b) Explain why the car reaches a top speed even though the thrust force remains constant at 3500 N.

.....

.....

.....

.....

.....

.....

(3)

(c) The diagram shows a car and a van.

The two vehicles have the same mass and identical engines.

Explain why the top speed of the car is higher than the top speed of the van.

.....

.....

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.....

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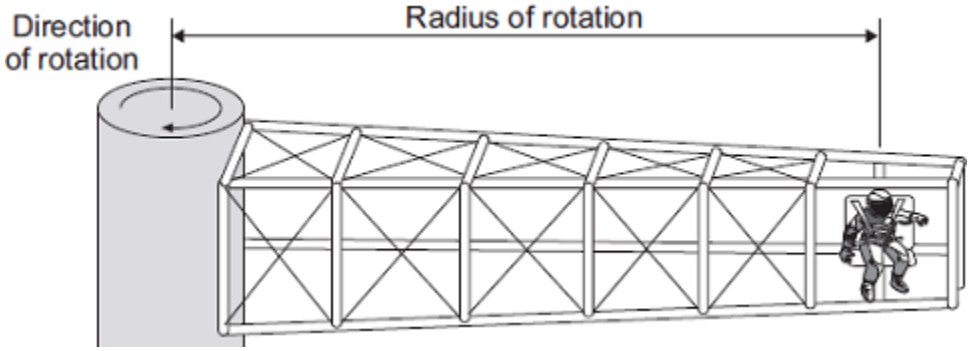
.....

(4)

(Total 11 marks)

28 The diagram shows a ‘G-machine’. The G-machine is used in astronaut training.



The G-machine moves the astronaut in a horizontal circle.

(a) When the G-machine is rotating at constant speed, the astronaut is accelerating.

State the name and direction of the force causing the astronaut to accelerate.

Name of force .....

Direction of force .....

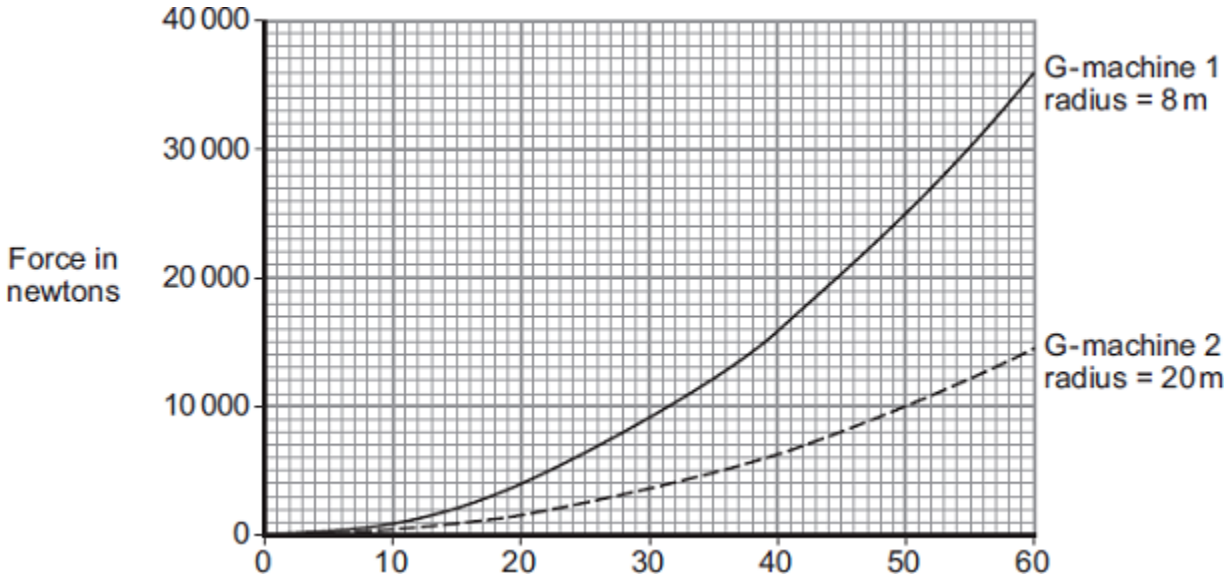
.....

(2)

(b) The force causing the astronaut to move in a circle is measured.

The graph shows how the speed of the astronaut affects the force causing the astronaut to move in a circle for two different G-machines.

The radius of rotation of the astronaut is different for each G-machine.



(i) State **three** conclusions that can be made from the graph.

1 .....

.....

2 .....

.....

3 .....

.....

(3)

(ii) The speed of rotation of G-machine 1 is increased from 20 m/s to 40 m/s.

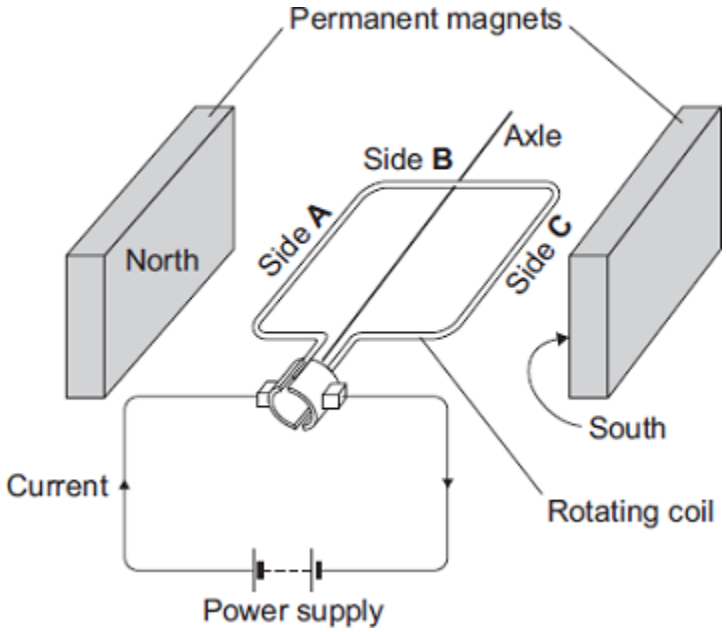
Determine the change in force on the astronaut.

.....

Change in force = ... N

(1)

(c) Each G-machine is rotated by an electric motor. The diagram shows a simple electric motor.



(i) A current flows through the coil of the motor.

Explain why side **A** of the coil experiences a force.

.....

.....

.....

.....

(2)

(ii) Draw arrows on the diagram to show the direction of the forces acting on side **A** of the coil and side **C** of the coil.

(1)

(iii) When horizontal, side **B** experiences no force.

Give the reason why.

.....

.....

(1)

(d) While a G-machine is rotating, the operators want to increase its speed.

What can the operators do to make the G-machine rotate faster?

.....

.....

(1)

(e) The exploration of space has cost a lot of money.

Do you think spending lots of money on space exploration has been a good thing?

Draw a ring around your answer.

Yes **No**

Give a reason for your answer.

.....

.....

(1)

(Total 12 marks)

29 The figure below shows a skateboarder jumping forwards off his skateboard.

The skateboard is stationary at the moment the skateboarder jumps.

(a) The skateboard moves backwards as the skateboarder jumps forwards.

Explain, using the idea of momentum, why the skateboard moves backwards.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(b) The mass of the skateboard is 1.8 kg and the mass of the skateboarder is 42 kg.

Calculate the velocity at which the skateboard moves backwards if the skateboarder jumps forwards at a velocity of 0.3 m / s.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

.....

.....

Velocity of skateboard = ... m / s

(3)

(Total 6 marks)

30 (a) A car driver sees the traffic in front is not moving and brakes to stop his car.

The stopping distance of a car is the thinking distance plus the braking distance.

(i) What is meant by the 'braking distance'?

.....

.....

(1)

(ii) The braking distance of a car depends on the speed of the car and the braking force.

State **one** other factor that affects braking distance.

.....

.....

(1)

(iii) How does the braking force needed to stop a car in a particular distance depend on the speed of the car?

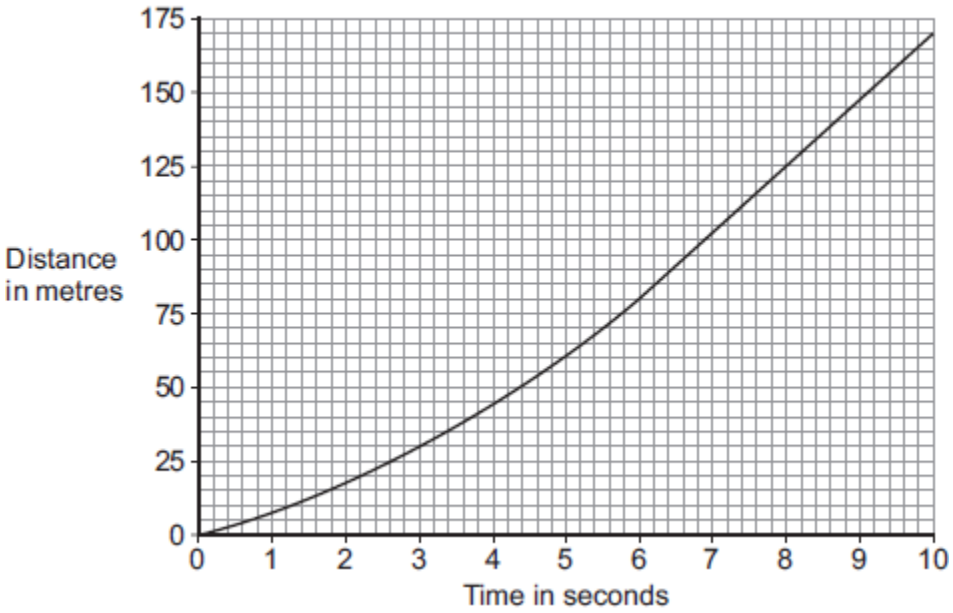
.....

.....

(1)

(b) **Figure 1** shows the distance−time graph for the car in the 10 seconds before the driver applied the brakes.

Figure 1



Use **Figure 1** to calculate the maximum speed the car was travelling at.
Show clearly how you work out your answer.

.....

.....

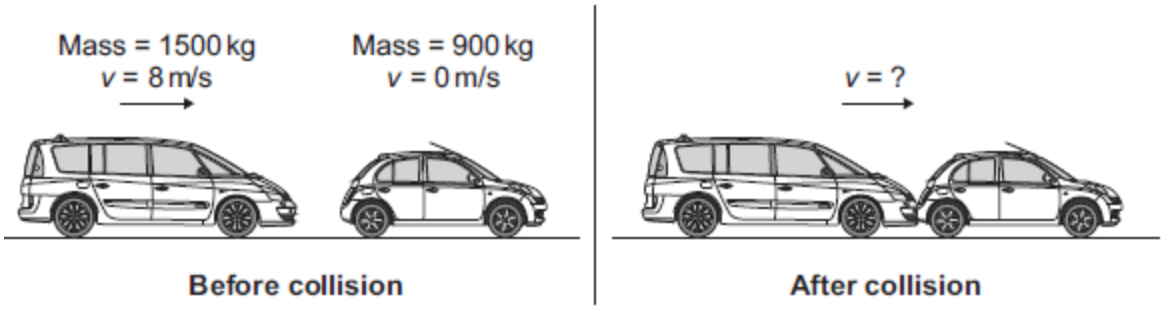
Maximum speed = ... m / s

(2)

(c) The car did not stop in time. It collided with the stationary car in front, joining the two cars together.

Figure 2 shows both cars, just before and just after the collision.

Figure 2



(i) The momentum of the two cars was conserved.

What is meant by the statement 'momentum is conserved'?

.....

.....

(1)

(ii) Calculate the velocity of the two joined cars immediately after the collision.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

.....

Velocity = ... m / s

(3)

(d) Since 1965, all cars manufactured for use in the UK must have seat belts.

It is safer for a car driver to be wearing a seat belt, compared with not wearing a seat belt, if the car is involved in a collision.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(Total 13 marks)

31 (a) The stopping distance of a vehicle is made up of two parts, the thinking distance and the braking distance.

(i) What is meant by *thinking distance*?

.....

.....

(1)

(ii) State **two** factors that affect thinking distance.

1 .....

.....

2 .....

.....

(2)

(b) A car is travelling at a speed of 20 m/s when the driver applies the brakes. The car decelerates at a constant rate and stops.

(i) The mass of the car and driver is 1600 kg.

Calculate the kinetic energy of the car and driver before the brakes are applied.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Kinetic energy = ... J

(2)

(ii) How much work is done by the braking force to stop the car and driver?

Work done = ... J

(1)

(iii) The braking force used to stop the car and driver was 8000 N.

Calculate the braking distance of the car.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Braking distance = ... m

(2)

(iv) The braking distance of a car depends on the speed of the car and the braking force applied.

State **one** other factor that affects braking distance.

.....

.....

(1)

(v) Applying the brakes of the car causes the temperature of the brakes to increase.

Explain why.

.....

.....

.....

.....

(2)

(c) Hybrid cars have an electric engine and a petrol engine. This type of car is often fitted with a regenerative braking system. A regenerative braking system not only slows a car down but at the same time causes a generator to charge the car's battery.

State and explain the benefit of a hybrid car being fitted with a regenerative braking system.

.....

.....

.....

.....

.....

.....

(3)

(Total 14 marks)

32 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.

Use the correct equation from **Section A** of the Physics Equations Sheet.

.....

.....

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)

33 A number of different forces act on a moving vehicle.

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

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

Tick (✓) **one** box.

	Tick (✓)
2000 N	
3000 N	
4000 N	

(1)

(ii) What causes most of the resistive force?

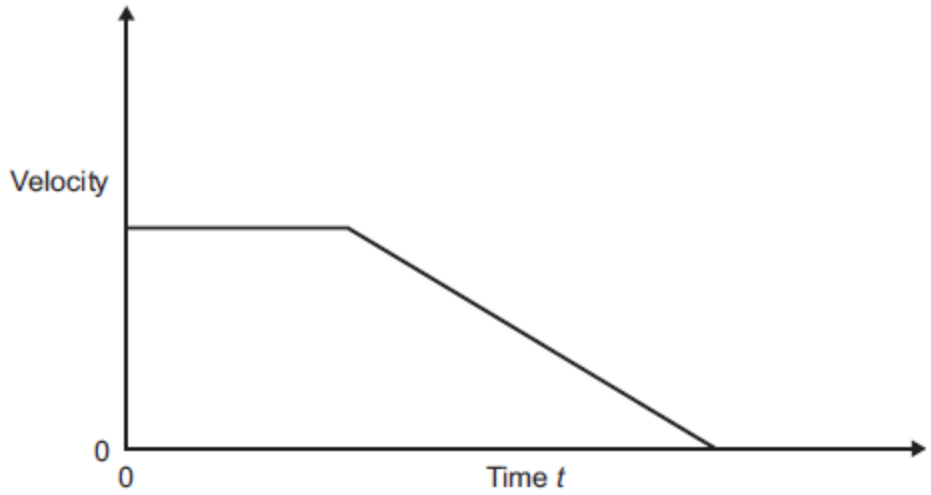
Tick (✓) **one** box.

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

(1)

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

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



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

Tick (✓) **one** box.

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

(1)

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

Tick (✓) **one** box.

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

(1)

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

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

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

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

(3)

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

Thinking distance and braking distance affect stopping distance.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)

(Total 13 marks)

Mark schemes

1

(a) (i) 16 000

*allow **1** mark for correct substitution ie 3200 × 5*

2

(ii) 16 000 or their (a)(i)

1

(iii) less than

1

(b) increases

1

decreases

correct order only

1

[6]

2

(a) (i) mass

*do **not** accept weight*

1

speed

accept velocity

answers can be in either order

1

(ii) zero

accept nothing

1

(b) (i) 100

*allow **1** mark for correct substitution of data*

2

(ii) conserved

1

[6]

3

(a) time

correct order only

1

force

1

(b) The car tyres being badly worn

1

(c) (i) braking distance increases with speed

accept positive correlation

*do **not** accept stopping distance for braking distance*

1

relevant further details, eg

- but not in direct proportion
- and increases more rapidly after 15 m/s

accept any speed between 10 and 20

accept numerical example

- double the speed, braking distance increases × 4

1

(ii) line drawn above existing line starting at the origin

as speed increases braking distance must increase
each speed must have a single braking distance

1

(d) (i) reaction time / reaction (of driver) does not depend on speed (of car)

1

(ii) (on the reduced speed limit roads) over the same period of time

accept a specific time, eg 1 year

1

monitor number of accidents before and after (speed limit reduced)

*allow **1** mark only for record number of vehicles / cars using the (20 mph) roads **or** collect data on accidents on the (20 mph) roads*

to score both marks the answer must refer to the roads with the reduced speed limit

1

[9]

4 (a) **Y**

accept the one in the middle
accept 90

1

has the biggest mass

reason does not score if X or Z is chosen
accept weight for mass
accept weighs the most
accept they are the heaviest
accept has a larger mass
*do **not** accept weighs 90kg's on its own*
biggest/larger on its own is not sufficient

1

(b) increases

1

[3]

5 (a) any **two** from:

- (make shape / body) more streamlined

  accept a correct description
  accept lower the seating position of the driver

- increase power of engine

  faster engine is insufficient

- reduce mass / weight (of go-kart)

  change wheel size is insufficient

2

(b) (i) A–B

reason only scores if A–B is chosen

1

steepest / steeper gradient / slope

1

(iii) 1820

*allow **1** mark for correct substitution, ie 140 × 13 provided no subsequent step shown*

2

[6]

6 (a) 4 (N)

*allow **1** mark for correct substitution into correct equation*
ie 0.4 × 10

2

(b) 4.8

*their (a) × 1.2 correctly calculated gains **2** marks*

*allow **1** mark for substitution into correct equation*
ie 4 × 1.2 or their (a)(i) × 1.2

2

joule or J

1

[5]

7 (a) (i) zero

accept nothing

1

speed is zero

accept not moving

1

(ii) A

1

largest mass **or** weight

accept heaviest luggage

*do **not** accept largest luggage*

1

(iii) momentum does change

accept yes

1

direction is changing

accept velocity is changing

*do **not** accept answers in terms of speed changing*

1

(iv) kg m/s

1

[7]

8 (a) (i) 1500

*allow **1** mark for subtraction shown ie 2000 – 500*

2

(ii) it accelerates

1

in a forward direction

accept gains speed/velocity

1

(b) (i) 23 (m)

1

(ii) 20 (m)

only this answer

1

(iii) any **one** from:

- drinking alcohol
- taking drugs
- tired

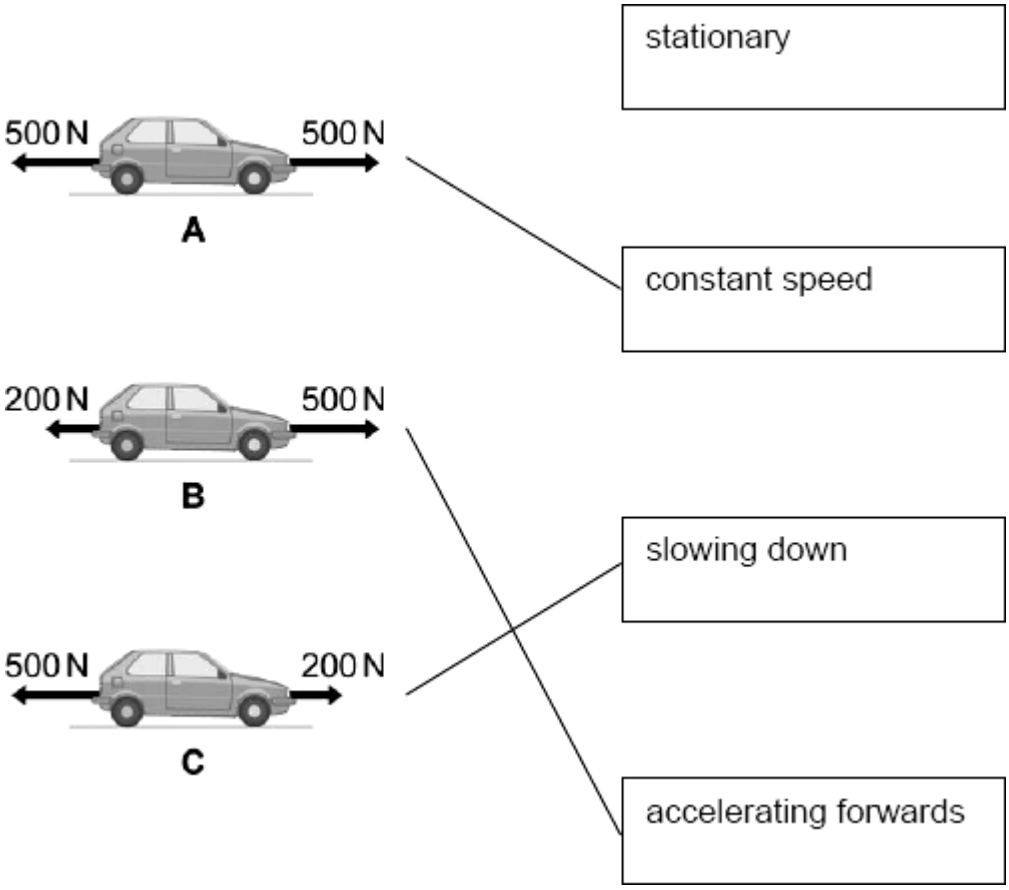
accept (a specific) distraction

accept any factor that affects the drivers reactions

1

[7]

9 (a) *3 lines drawn*
all correct
*allow **1** mark for each correct line*
if two or more lines are drawn from any diagram then all these lines are incorrect



3

(b) (i) horizontal arrow to the right
judge by eye
accept an arrow drawn outside the box if it is labelled correctly

1

(ii) horizontal arrow to the left
judge by eye
accept an arrow drawn outside the box if it is labelled correctly

1

(iii) equal to

1

(iv) to measure the forces exerted on the dummy during the impact

1

[7]

10 (a) (i) not moving

1

(ii) straight line from origin to (200,500)

ignore a horizontal line after (200,500)

1

(b) 35 000

*allow **1** mark for correct substitution, ie 14 000 × 2.5 provided no subsequent step*

an answer of 87 500 indicates acceleration (2.5) has been squared and so scores zero

2

[4]

11 (a) 96 (m)

1

(b) (i) similar shape curve drawn <u>above</u> existing line going <u>through (0,0)</u>

*allow **1** mark for any upward smooth curve or straight upward line <u>above</u> existing line going through (0,0)*

2

(ii) Rain on the road

1

(c) (i) all three lines correctly labelled

*allow **1** mark for one correctly labelled*

top line – **C**

accept 1.2

middle line – **B**

accept 0.9

bottom line – **A**

accept 0.7

2

(ii) any **two** from:

- (table has) both variables are together
  accept tired and music as named variables
- both (variables) could / would affect the reaction time
  accept cannot tell which variable is affecting the drive (the most)
- cannot tell original contribution
- need to measure one (variable) on its own
  accept need to test each separately
- need to control one of the variables
  fair test is insufficient

2

[8]

12 (a) (i) constant speed

*do **not** accept normal speed*
*do **not** accept it is stopped / stationary*

1

in a straight line

accept any appropriate reference to a direction
*constant velocity gains **2** marks*
*'not accelerating' gains **2** marks*
*terminal velocity alone gets **1** mark*

1

(ii) goes down owtte

accept motorbike (it) slows down

1

(b) (i) 20 (m/s)

ignore incorrect units

1

(ii) acceleration = $\frac{\text{change in velocity}}{\text{time (taken)}}$

*do **not** accept velocity for change in velocity*
accept change in speed

accept $a = \frac{v - u}{t}$ ***or*** $a = \frac{v_1 - v_2}{t}$

or $a = \frac{\Delta v}{t}$

*do **not** accept* $a = \frac{v}{t}$

1

(iii) 4

or their (b)(i) ÷ 5

*allow **1** mark for correct substitution*

2

m/s^2

*m/s/s **or** ms^{-2} **or** metres per second squared **or** metres per second per second*

1

(c) vehicle may skid / slide

loss of control / brakes lock / wheels lock
*accept greater stopping distance **or** difficult to stop*

1

due to reduced friction (between tyre(s) and road)

accept due to less grip
*do **not** accept <u>no</u> friction*

1

(d) any **three** from:

*do **not** accept night time / poor vision*

- increased speed
- reduced braking force
- slower (driver) reactions

*NB specific answers may **each** gain credit eg tiredness (1), drinking alcohol (1), using drugs (1), driver distracted (1) etc*

- poor vehicle maintenance

*specific examples may **each** gain credit eg worn brakes or worn tyres etc*

- increased mass / weight of vehicle

accept large mass / weight of vehicle

- poor road surface
- more streamlined

*if candidates give three answers that affect stopping distance but not specific to increase award **1** mark only*

3

[13]

13 (a) 2.75

*allow **1** mark for correct substitution, ie* $\frac{11}{4}$

or $\frac{23-12}{4}$

provided no subsequent step shown

2

m/s^2

1

(b) driving force increases

1

frictional force increases

accept air resistance / drag for frictional force

1

driving force > frictional force

1

[6]

14 (a) (i) 10800

allow 1 mark for correct substitution i.e. 900 × 12

2

(ii) arrow pointing towards the left

allow anywhere on the diagram or at bottom of the page

1

(b) zero

accept 0 / none / nothing

1

velocity is zero

accept speed for velocity

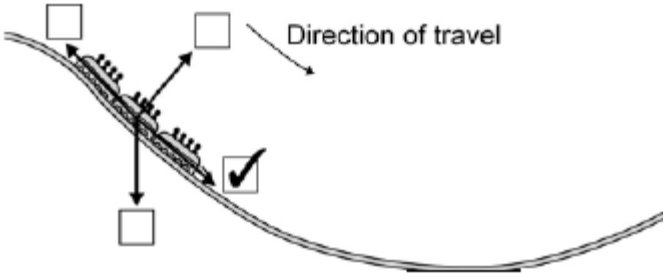
accept stopped / not moving

accept a calculation i.e. 900 × 0 = 0

1

[5]

15 (a) correct box ticked



1

(b) (i) 30

ignore added units

1

(ii) 2250 **or** their (b)(i) × 75 correctly calculated

*allow **1** mark for correct substitution ie 75 × 30 **or** their (b)(i) × 75 provided no subsequent step shown*

*an answer of 750 gains **1** mark only if answer to (b)(i) is 10*

2

[4]

16 (a) (i) Constant speed

2

(ii) Accelerates to higher constant speed

1

(b) (i) Points correct (allow one major or two minor mistakes)
Line correct (for their points)

2

(ii) 5 m/s
or 5
gets 2 marks

or correct unit
gets 1 mark mark

3

(c) (i) 50 s or 50
gets 2 marks

or t = d/v
gets 1 mark

3

(ii) Line correct (of gradient 4 and spans 30 consecutive seconds)

1

(d) (i) 0.04 or 6/15
gets 2 marks

or a = v/t
gets 1 mark

3

[15]

17 (a) (moving in) different / opposite directions
accept one has positive momentum the other negative momentum
accept they have different velocities

1

(b) (i) momentum before = momentum after
or
(total) momentum stays the same
accept no momentum is lost
accept no momentum is gained

1

(ii) 2.2

*allow **1** mark for calculation of teenagers' momentum as 22 (kgm/s) and*

*allow **1** mark for correct statement, eg momentum before = momentum after*

or

*allow **2** marks for a numerical expression of above, eg*

55 × 0.4 = m × 10

***or** 0 = (55 × 0.4) + (m × (-10))*

3

(c) any **two** from:

- work is done
- (against) friction

  any reference to increasing friction negates this marking point
- (transforming) (kinetic) energy into heat

2

[7]

18 (i) momentum (change in) = mass × velocity (change in)

accept ... speed

1

(ii) 9000

*1500 × 6 for 1 mark but **not** from incorrect equation*

2

kilogram metre(s) per second **or** kg m/s

1

(iii) **either** 7.5 (m/s)

or change in momentum of car B change in momentum of car A (1)
9000 = 1200 × v (1)

or v = 9000 ÷ 1200 (1)

or error carried forward from part (ii)

examples

5 (m/s) if 6000 offered in (ii) (3)

12.5(m/s) if 15000 offered in (ii)

(3)

3

[7]

19 (a) (i) tiredness / boredom
drugs
alcohol
distraction

any two for 1 mark each

2

(ii) A greater / longer
B no effect
C greater / longer

each for 1 mark

3

(b) on a wet road: there is less friction / grip

for 1 mark

braking distance is greater / takes longer to stop
or car skids / slides forward

for 1 mark

2

(c) (i) deceleration = gradient or 30 / 4.8

each for 1 mark

2

(ii) force = mass × acceleration or 900 × 6.25

each for 1 mark

2

(iii) distance = area under graph or 0.5 × 4.8 × 30 **or** average speed × time **or** 15 × 4.8
Accept answer in terms of change in k.e. = work done
if incorrect unit given (eg 72km) then no mark

each for 1 mark

2

[13]

20 (a) Total momentum (of a system of bodies) remains constant

accept momentum before (a collision) = momentum after (a collision)

1

Provided no external force acts

1

(b) (i) rotate the compressor

1

(ii) • fuel is mixed with the air and ignited

• causing an increase in the pressure
or temperature **or** speed of the gases
accept air out faster than air in
accept gases have momentum ***or***

• force backwards

• exhaust gases have momentum
(backwards) **or** force (backwards)
if the answer is in terms of force then this third point must be scored before the fourth can be credited

• engine **or** aircraft has (equal) momentum forwards **or** force forwards

4

(c) m = 350

answer 0.35 one mark only
allow one mark if 105 000 ***or*** *475-175* ***or*** *300 have been used*

2

[9]

21 (a) (i) momentum before = momentum after
or
(total) momentum stays the same
accept no momentum is lost
accept no momentum is gained

1

(ii) an external force acts (on the colliding objects)
accept colliding objects are not isolated

1

(b) (i) 9600

allow ***1*** *mark for correct calculation of momentum before or after*
ie 12000 or 2400
or
correct substitution using change in velocity = 8 m/s
ie 1200 × 8

2

kg m/s
this may be given in words rather than symbols
or
Ns

1

(ii) 3 or their (b)(i) ÷ 3200 correctly calculated

*allow **1** mark for stating momentum before = momentum after*

or

clear attempt to use conservation of momentum

2

[7]

22 (a) mass and velocity/speed multiplied

for 1 mark each

2

(b) total momentum before and after collision are the same

for 1 mark each

2

(c) (i) $M_AU_A + M_BU_B = (M_A + M_B)v$
$2 \times 6 = (2 + 1)v$
$v = 4$
m/s

for 1 mark each

4

(ii) $1/2\ mv^2$ (before) – $1/2\ mv^2$ (after) $1/2\ 2.36 – 1/2\ 3.16 = 12$
J

for 1 mark each

4

[12]

23 (a) Throughout the question the equation M = mv is credited once only. This is the first time it appears. The mark scheme below assumes it will appear in (i).

(i) M = mv m × v sufficient **not** m × s, mass × speed
= 1500 × 8
= 12 000
(see marking of calculations)

3

(ii) M = mv
M = 2000 × 1 = 2000
(see marking of calculations)

2

(iii) must be sum of (i) and (ii) 14 000

for 1 mark

1

(b) total mass = 3500
momentum = 14 000 (conserved)
M = mv **or** v = 14 000/3500
v = 4
m/s

5

(c) (i) it reduces

for 1 mark

1

(ii) ke to sound/heat

for 1 mark

1

(iii) change smaller

for 1 mark

1

[14]

24 (a) (i) 6

for 1 mark

1

(ii) 6

for 1 mark

1

(iii) 1.5

for 1 mark

1

(iv) 4.5

for 1 mark

1

(v) 3

for 1 mark

1

(b) initial ke = 12J;

final ke = 0.75J + 6.75J;

energy loss = 4.5J

for 1 mark each

(If wrong; any correct ke value gains 1 mark; maximum of 2
path through calculation clear and correct gains 1 mark)
(ignore either ball – max 1 mark)

3

[8]

25 (a) (i) direction indicated

*accept to right **or** + or – **or** arrow drawn on diagram*

1

300

1

kg m/s **or** Ns

1

(ii) 300 (kg m/s)

1

(iii) there is no change in the total KE
or total KE is constant

1

(b) momentum of person towards jetty = momentum of boat away from jetty
or total momentum is constant so as person goes one way boat goes the other

***1** mark is for the idea of momentum conservation*
***1** is for direction*

2

(c) time of collision increases

*do **not** accept momentum is conserved*

1

so a smaller force is exerted

*do **not** accept designed to absorb energy **or** momentum*

1

to produce the same change of momentum **or** impulse force

*do **not** accept cushions fall*

1

[10]

26 (a) direction

1

(b) 54 000

*allow **1** mark for calculating and identifying momentum as 10 800*
or
*allow **1** mark for correct substitution into second equation*
ie $\frac{1200 \times 9}{0.2}$

2

(c) increases the time taken (for head) to stop

accept increases impact time
*do **not** accept reference to slowing down time unless qualified*

1

decreases rate of change in momentum

accept reduces acceleration / deceleration

*accept increases the time taken to reduce momentum to zero is worth **2** marks*

reduces momentum is insufficient

1

reduces the force (on the head)

1

[6]

27 (a) 1.25

*allow **1** mark for correct resultant force ie 1500N*

*allow **2** marks for correct transformation and substitution*

ie $\frac{1500}{1200}$

*allow **1** mark for a correct transformation but clearly substituting an incorrect value for force*

eg = $\frac{3500}{1200}$

3

m/s^2

1

(b) as speed increases so does the size of the drag force

accept frictional force / resistive force / air resistance for drag

1

eventually the drag force becomes equal to the thrust

1

the resultant force is now equal to zero and therefore there is no further acceleration

1

(c) the car and van will reach top speed when the forward force equals the drag force

accept air resistance / frictional / resistive force for drag force

1

the drag force at any speed is smaller for the car than for the van

1

as the car is more streamlined

1

therefore the car's drag force will equal the forward force at a higher speed

1

allow converse throughout

[11]

28 (a) centripetal (force)

allow tension (between astronaut and seatbelt)

1

towards the centre (of the G-machine / circle)

*do **not** accept towards the centre of the Earth*

allow inwards

1

(b) (i) the greater the speed (of a centrifuge), the greater the force

answers must be comparative

accept velocity for speed

accept positive correlation between speed and force

speed and force are not proportional – treat as neutral

1

the smaller the radius, the greater the force (at a given speed)

*allow **(G machine) 1** has / produces a greater force (than **G machine 2**) at the same speed*

must be comparative, eg a small radius produces a large force = 0 marks on own

1

as the speed increases the rate of change in force increases

accept force is proportional to the square of the speed

or

doubling speed, quadruples the force

accept any clearly correct conclusion

1

(ii) 12000 (N)

or

12 k(N)

1

(c) (i) the current (in the coil) creates a magnetic field (around the coil)

accept the coil is an electromagnet

1

so the magnetic field of the coil interacts with the (permanent) magnetic field of the magnets (producing a force)

accept the two magnetic fields interact (producing a force)

*if no marks scored an answer in terms of current is perpendicular to the (permanent) magnetic field is worth max **1** mark*

1

(ii) vertically downwards arrow on side A

one arrow insufficient

and

vertically upwards arrow on side C

1

(iii) the current is parallel to the magnetic field

allow the current and magnetic field are in the same direction

allow it / the wire is parallel to the magnetic field

1

(d) increase the current / p.d. (of the coil)

accept decrease resistance

accept voltage for p.d.

accept increase strength of magnetic field / electromagnet

1

(e) yes with suitable reason

or

no with suitable reason

eg

yes *– it has increased our knowledge*

yes *– It has led to more (rapid) developments / discoveries (in technology / materials / transport) accept specific examples*

no *– the money would have been better spent elsewhere on such things as hospitals (must quote where, other things not enough)*

no *mark for just* ***yes*** */* ***no***

reason must match ***yes*** */* ***no***

1

[12]

29 (a) momentum before (jumping) = momentum after (jumping)

accept momentum (of the skateboard and skateboarder) is conserved

1

before (jumping) momentum of skateboard and skateboarder is zero

accept before (jumping) momentum of skateboard is zero

accept before (jumping) total momentum is zero

1

after (jumping) skateboarder has momentum (forwards) so skateboard must have (equal) momentum (backwards)

answers only in terms of equal and opposite forces are insufficient

1

(b) 7

*accept –7 for **3** marks*

*allow **2** marks for momentum of skateboarder equals 12.6*

or

0 = 42 × 0.3 + (1.8 × –v)

or

*allow **1** mark for stating use of conservation of momentum*

3

[6]

30 (a) (i) distance travelled under the braking force

accept distance travelled between applying the brakes and stopping

1

(ii) any **one** from:

- icy / wet roads

  accept weather (conditions)
- (worn) tyres
- road surface

  accept gradient of road
- mass (of car and passengers)

  accept number of passengers
- (efficiency / condition of the) brakes.

  friction / traction is insufficient

1

(iii) greater the speed the greater the braking force (required)

must mention both speed and force

1

(b) 22.5

*allow **1** mark for showing correct use of the graph with misread figures*

or

for showing e.g. 90÷4

*an answer 17 gains **1** mark*

any answer such as 17.4 or 17.5 scores 0

2

(c) (i) momentum before = momentum after

or

(total) momentum stays the same

accept no momentum is lost

accept no momentum is gained

ignore statements referring to energy

1

(ii) 5

*allow **2** marks for correctly obtaining momentum before as 12 000*

or

*allow **2** marks for*

1500 × 8 = 2400 × v

or

*allow **1** mark for a relevant statement re conservation of momentum*

or

*allow **1** mark for momentum before = 1500 × 8*

3

(d) the seat belt stretches

1

driver takes a longer (*impact*) time to slow down and stop (than a driver hitting a hard surface / windscreen / steering wheel)

1

for the (same) change of momentum

accept so smaller deceleration / negative acceleration

1

a smaller force is exerted (so driver less likely to have serious injury than driver without seat belt)
or
the seat belt stretches ***(1)***

do not accept impact for force

driver travels a greater distance while slowing down and stopping (than a driver hitting a hard surface / windscreen / steering wheel) ***(1)***

for (same) amount of work done ***(1)***

accept for (same) change of KE

a smaller force is exerted (so driver less likely to have serious injury than driver without seat belt) ***(1)***

do not accept impact for force

1

[13]

31 (a) (i) distance vehicle travels during driver's reaction time

accept distance vehicle travels while driver reacts

1

(ii) any **two** from:

- tiredness
- (drinking) alcohol
- (taking) drugs
- speed
- age

accept as an alternative factor distractions, eg using a mobile phone

2

(b) (i) 320 000

*allow **1** mark for correct substitution, ie* $\frac{1}{2} \times 1600 \times 20^2$ *provided no subsequent step shown*

2

(ii) 320000 **or** their (b)(i)

1

(iii) 40

or

$\frac{\text{their (b)(ii)}}{8000}$ correctly calculated

*allow **1** mark for statement work done = KE lost*

or

*allow **1** mark for correct substitution, ie*
*8000 × distance = 320 000 **or** their (b)(ii)*

2

(iv) any **one** from:

- icy / wet roads
  accept weather conditions
- (worn) tyres
- road surface
- mass (of car and passengers)
  accept number of passengers
- (efficiency / condition of the) brakes

1

(v) (work done by) friction
(between brakes and wheel)

*do **not** accept friction between road and tyres / wheels*

1

(causes) decrease in KE and increase in thermal energy

accept heat for thermal energy accept
KE transferred to thermal energy

1

(c) the battery needs recharging less often

accept car for battery

1

or
increases the range of the car

*accept less demand for other fuels **or** lower emissions **or** lower fuel costs*
environmentally friendly is insufficient

as the efficiency of the car is increased

accept it is energy efficient

1

the decrease in (kinetic) energy / work done charges the battery (up)

accept because not all work done / (kinetic) energy is wasted

1

[14]

32 (a) terminal

1

(b) 5.4 (kg)

*correct substitution of 54 = m × 10 gains **1** mark*

2

(c) (i) 0< a <10

1

some upward force

accept some drag / air resistance

1

reduced resultant force

1

(ii) 0

1

upward force = weight (gravity)

1

resultant force zero

1

[9]

33 (a) (i) 3000 N

1

(ii) air resistance

1

(b) (i) the gradient of the sloping line

1

(ii) the area under the graph

1

(iii) horizontal line above previous one

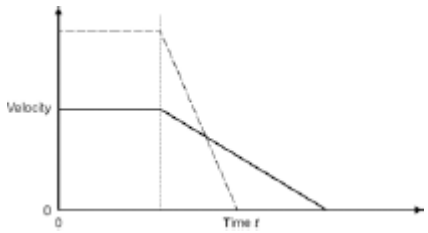
1

for the same time

1

sloping line cutting time axis before previous line

eg



1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
One factor is given that affects thinking distance
or
one factor is given that affects braking distance

Level 2 (3−4 marks)
One factor and a description of its effect is given for **either** thinking distance **or** braking distance

Level 3 (5−6 marks)
One factor and a description of its effect is given for **both** thinking distance and braking distance
plus
some extra detail

Examples of the points made in the response
stopping distance = thinking distance + braking distance

the faster the car travels the greater the stopping distance

thinking distance is the distance travelled from when the driver sees an obstacle to when the brakes are applied

braking distance is the distance travelled from when the brakes are applied to when the car stops

thinking distance:
- tiredness increases thinking distance
- taking drugs increases thinking distance
- drinking alcohol increases thinking distance
- distractions in the car increase thinking distance.

braking distance:
- poor condition of brakes increases braking distance
- poor condition of tyres increases braking distance
- wet roads increase braking distance
- icy roads increase braking distance.

6

[13]