New Document 1

Name: ____________________________
Class: ____________________________
Date: ____________________________

Time: 221 minutes
Marks: 220 marks

Comments:
Q1.

The diagram shows a boat pulling a water skier.

(a) The arrow represents the force on the water produced by the engine propeller. This force causes the boat to move. Explain why.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(b) The boat accelerates at a constant rate in a straight line. This causes the velocity of the water skier to increase from 4.0 m/s to 16.0 m/s in 8.0 seconds.

(i) Calculate the acceleration of the water skier and give the unit.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

Acceleration = _________________________

(3)

(ii) The water skier has a mass of 68 kg. Calculate the resultant force acting on the water skier while accelerating.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

Resultant force = _________________________ N

(2)

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

The force from the boat pulling the water skier forwards

less than

will be the same as the answer to part (b)(ii).
Q2.

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 __________ velocity.

- frictional
- initial
- terminal

(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.

Mass of chest pack = ____________________ kg

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

Immediately after leaving the aircraft, the skydiver’s acceleration was 10 m / s².

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

Estimate ____________________ m / s²

Explanation ______________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________
Q3.
(a) The diagram shows the forces acting on a parachutist in free fall.

Air resistance

The parachutist has a mass of 75 kg.
Calculate the weight of the parachutist.

\[ \text{gravitational field strength} = 10 \text{ N/kg} \]

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

\[ \text{Weight} = \text{________________________} \]

(3)

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

Explain your value of acceleration in terms of forces.

Estimate \[ \text{________________________} \]

Explanation \[ \text{________________________} \]

(3)

(Total 9 marks)
In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

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

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

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(c) A student wrote the following hypothesis.

‘The larger the area of a parachute, the slower a parachutist falls.’

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

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

Name one other control variable in this experiment.

______________________________________________________________

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

Write your answer in the box.

[ ]

Give a reason for your answer.

______________________________________________________________

______________________________________________________________

______________________________________________________________

(Total 12 marks)

Q4.

(a) The diagram shows a steel ball-bearing falling through a tube of oil. The forces, \( L \) and \( M \), act on the ball-bearing.
What causes force $L$?

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

(i) Explain, in terms of the forces, $L$ and $M$, why the ball-bearing accelerates at first but then falls at constant speed.
(ii) What name is given to the constant speed reached by the falling ball-bearing?

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

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

Speed = ______________________________ m/s

Q5.

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.

(Total 7 marks)
(ii) Force $Y$ is caused by \text{gravity}. \hfill (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 $Y$,

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

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

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

(1)

(Total 5 marks)

Q6.

(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.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Kinetic energy = _________________________ J

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

Work done = _________________________ J

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

Calculate the braking distance of the car.

                                                                                     Braking distance = _________________________ m

(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.

                                                                                     (2)
Q7.

(a) A car driver makes an emergency stop.

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

Stopping distance = __________________________ m

(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.
(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

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

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

<table>
<thead>
<tr>
<th>Car driver</th>
<th>Condition</th>
<th>Reaction time in second</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Wide awake with no distractions</td>
<td>0.7</td>
</tr>
<tr>
<td>B</td>
<td>Using a hands-free mobile phone</td>
<td>0.9</td>
</tr>
<tr>
<td>C</td>
<td>Very tired and listening to music</td>
<td>1.2</td>
</tr>
</tbody>
</table>

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.
Q8.

An investigation was carried out to show how thinking distance, braking distance and stopping distance are affected by the speed of a car.

The results are shown in the table.

<table>
<thead>
<tr>
<th>Speed in metres per second</th>
<th>Thinking distance in metres</th>
<th>Braking distance in metres</th>
<th>Stopping distance in metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
<td>14</td>
<td>43</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
<td>24</td>
<td>36</td>
</tr>
<tr>
<td>25</td>
<td>15</td>
<td>38</td>
<td>53</td>
</tr>
<tr>
<td>30</td>
<td>18</td>
<td>55</td>
<td>73</td>
</tr>
</tbody>
</table>

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

As speed increases, thinking distance decreases.

As speed increases, braking distance decreases.

(b) One of the values of stopping distance is incorrect.

Draw a ring around the incorrect value in the table.

Calculate the correct value of this stopping distance.

(2)
Stopping distance = ________________ m

(c) (i) Using the results from the table, plot a graph of braking distance against speed.

Draw a line of best fit through your points.

(ii) Use your graph to determine the braking distance, in metres, at a speed of 22 m/s.

Braking distance = ________________ m

(d) The speed–time graph for a car is shown below.

While travelling at a speed of 35 m/s, the driver sees an obstacle in the road at time $t = 0$. The driver reacts and brakes to a stop.
(i) Determine the braking distance.

\[ \text{Braking distance} = \underline{ \text{______________} } \text{ m} \] (3)

(ii) If the driver was driving at 35 m / s on an icy road, the speed–time graph would be different.

Add another line to the speed–time graph above to show the effect of travelling at 35 m / s on an icy road and reacting to an obstacle in the road at time \( t = 0 \).

(e) A car of mass 1200 kg is travelling with a velocity of 35 m / s.

(i) Calculate the momentum of the car.

Give the unit.

\[ \text{Momentum} = \underline{ \text{______________} } \text{ kg m/s} \] (3)

(ii) The car stops in 4 seconds.

Calculate the average braking force acting on the car during the 4 seconds.

\[ \text{Force} = \underline{ \text{______________} } \text{ N} \] (2)
Q9.

The stopping distance of a car is the sum of the thinking distance and the braking distance.

The table below shows how the thinking distance and braking distance vary with speed.

<table>
<thead>
<tr>
<th>Speed in m/s</th>
<th>Thinking distance in m</th>
<th>Braking distance in m</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>6</td>
<td>6.0</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
<td>13.5</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
<td>24.0</td>
</tr>
<tr>
<td>25</td>
<td>15</td>
<td>37.5</td>
</tr>
<tr>
<td>30</td>
<td>18</td>
<td>54.0</td>
</tr>
</tbody>
</table>

(a) What is meant by the braking distance of a vehicle?

___________________________________________________________________

___________________________________________________________________

(1)

(b) The data in the table above refers to a car in good mechanical condition driven by an alert driver.

Explain why the stopping distance of the car increases if the driver is very tired.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(2)

(c) A student looks at the data in the table above and writes the following:

thinking distance $\propto$ speed

thinking distance $\propto$ speed

Explain whether the student is correct.

___________________________________________________________________
(d) Applying the brakes with too much force can cause a car to skid.

The distance a car skids before stopping depends on the friction between the road surface and the car tyres and also the speed of the car.

Friction can be investigated by pulling a device called a ‘sled’ across a surface at constant speed.

The figure below shows a sled being pulled correctly and incorrectly across a surface.

The constant of friction for the surface is calculated from the value of the force pulling the sled and the weight of the sled.

Why is it important that the sled is pulled at a constant speed?

Tick one box.

- If the sled accelerates it will be difficult to control.
- If the sled accelerates the value for the constant of friction will be wrong.
- If the sled accelerates the normal contact force will change.

(e) If the sled is pulled at an angle to the surface the value calculated for the constant of friction would not be appropriate.

Explain why.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(f) By measuring the length of the skid marks, an accident investigator determines that the distance a car travelled between the brakes being applied and stopping was 22 m.

The investigator used a sled to determine the friction. The investigator then
calculated that the car decelerated at 7.2 m / s².

Calculate the speed of the car just before the brakes were applied.

Give your answer to two significant figures.

Use the correct equation from the Physics Equation Sheet.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

Speed = __________________________ m / s

(Total 11 marks)

Q10.

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.

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 ____________________ .

(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.
(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?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(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.

(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?

________________________________________________________________________
________________________________________________________________________

(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)

Q11.

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.)

   (1)

   Answer ____________________ N

   (Total 8 marks)

Q12.

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.

<table>
<thead>
<tr>
<th>Tick (√)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The area under the graph</td>
</tr>
<tr>
<td>The gradient of the sloping line</td>
</tr>
<tr>
<td>The intercept on the y-axis</td>
</tr>
</tbody>
</table>

(1)

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

Tick (√) one box.

<table>
<thead>
<tr>
<th>Tick (√)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The area under the graph</td>
</tr>
<tr>
<td>The gradient of the sloping line</td>
</tr>
<tr>
<td>The intercept on the y-axis</td>
</tr>
</tbody>
</table>

(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.

Q13.
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 ________________________

(ii) Explain why force X acts in an upward direction.
(iii) At first forces \( X \) and \( Y \) are unbalanced.  
Which of the forces will be bigger? ________________  

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

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  
\[ \text{increased} / \text{stayed the same} / \text{decreased}. \]

Force \( Y \) has  
\[ \text{increased} / \text{stayed the same} / \text{decreased}. \]

The speed of the sky-diver will  
\[ \text{increase} / \text{stay the same} / \text{decrease}. \]
(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?

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

Distance _______________ m

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

Time _______________ s

(iv) Calculate this speed.

______________________________________________________________

______________________________________________________________

______________________________________________________________

Speed _______________ m/s
Q14.

(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.

(i) Use the information in the diagram to calculate the change in the momentum of the car.

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.

______________________________________________________________
Q15.

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.

___________________________________________________________________
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___________________________________________________________________
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___________________________________________________________________

(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.

___________________________________________________________________
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___________________________________________________________________
Q16.

The diagram shows an air-driven toy. When the electric motor is switched on the fan rotates. The fan pushes air backwards making the toy move forwards.

(a) (i) The toy has a mass of 0.15 kg and moves forward with a velocity of 0.08 m/s. How is the momentum of the toy calculated?

Tick (√) one box.

0.15 + 0.08 = 0.230

0.15 ÷ 0.08 = 1.875

0.15 × 0.08 = 0.012

(ii) What is the unit of momentum?

Tick (√) one box.

kg m/s

m/s²

kg/m/s

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

The momentum of the air backwards is ___________ the momentum of the toy forwards.
(b) The electric motor can rotate the fan at two different speeds.

Explain why the toy moves faster when the fan rotates at the higher of the two speeds.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

(Total 5 marks)

Q17.
Quantities in physics are either scalars or vectors.

(a) Use the correct answers from the box to complete the sentence.

<table>
<thead>
<tr>
<th>acceleration</th>
<th>direction</th>
<th>distance</th>
<th>speed</th>
<th>time</th>
</tr>
</thead>
</table>

Velocity is __________________________ in a given ________________ .

(b) Complete the table to show which quantities are scalars and which quantities are vectors.

Put one tick (✓) in each row.

The first row has been completed for you.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Scalar</th>
<th>Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Acceleration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(c) The diagram shows two supermarket trolleys moving in the same direction.

Trolley A is full of shopping, has a total mass of 8 kg and is moving at a velocity of 2 m / s with a kinetic energy of 16 J.

Trolley B is empty, has a mass of 4 kg and is moving at a velocity of 0.5 m / s with a kinetic energy of 0.5 J.
(i) Calculate the momentum of both trolley A and trolley B.

Give the unit.

Momentum of trolley A = _______________
Momentum of trolley B = _______________
Unit __________

(4)

(ii) The trolleys in the diagram collide and join together. They move off together.

Calculate the velocity with which they move off together.

Velocity = _______________ m / s

(3)

(iii) In a different situation, the trolleys in the diagram move at the same speeds as before but now move towards each other.

Calculate the total momentum and the total kinetic energy of the two trolleys before they collide.

Total momentum = _______________

Total kinetic energy = _______________ J

(2)

(Total 14 marks)
Q18.
A paintball gun is used to fire a small ball of paint, called a paintball, at a target.
The figure below shows someone just about to fire a paintball gun.
The paintball is inside the gun.

(a) What is the momentum of the paintball before the gun is fired?
___________________________________________________________________
Give a reason for your answer.
___________________________________________________________________
___________________________________________________________________

(b) The gun fires the paintball forwards at a velocity of 90 m / s.
The paintball has a mass of 0.0030 kg.
Calculate the momentum of the paintball just after the gun is fired.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
Momentum = ____________________ kg m / s

(c) The momentum of the gun and paintball is conserved.
Use the correct answer from the box to complete the sentence.

| equal to | greater than | less than |

The total momentum of the gun and paintball just after the gun is fired will be ____________________ the total momentum of the gun and paintball before the gun is fired.

(Total 5 marks)
Q19.
(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.

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

(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.

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

What is meant by the statement ‘momentum is conserved’?

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

Velocity = ________________ m / s

(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.
Q20.
A student investigated the behaviour of springs. She had a box of identical springs.

(a) When a force acts on a spring, the shape of the spring changes.

The student suspended a spring from a rod by one of its loops. A force was applied to the spring by suspending a mass from it.

Figure 1 shows a spring before and after a mass had been suspended from it.

**Figure 1**

(i) State two ways in which the shape of the spring has changed.

1. ____________________________________________________________
2. ____________________________________________________________

(ii) No other masses were provided.

Explain how the student could test if the spring was behaving elastically.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
(2)
In a second investigation, a student took a set of measurements of force and extension. Her results are shown in Table 1.

<table>
<thead>
<tr>
<th>Force in newtons</th>
<th>0.0</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension in cm</td>
<td>0.0</td>
<td>4.0</td>
<td>12.0</td>
<td>16.0</td>
<td>22.0</td>
<td>31.0</td>
<td></td>
</tr>
</tbody>
</table>

(i) Add the missing value to Table 1.

Explain why you chose this value.

______________________________________________________________

______________________________________________________________

______________________________________________________________

(ii) During this investigation the spring exceeded its limit of proportionality. Suggest a value of force at which this happened. Give a reason for your answer.

Force = _________________ N

Reason _______________________________________________________

______________________________________________________________

(c) In a third investigation the student:

• suspended a 100 g mass from a spring
• pulled the mass down as shown in Figure 2
• released the mass so that it oscillated up and down
• measured the time for 10 complete oscillations of the mass
• repeated for masses of 200 g, 300 g and 400 g.

Figure 2
Her results are shown in Table 2.

<table>
<thead>
<tr>
<th>Mass in g</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>4.34</td>
<td>5.20</td>
<td>4.32</td>
<td>4.6</td>
</tr>
<tr>
<td>200</td>
<td>5.93</td>
<td>5.99</td>
<td>5.86</td>
<td>5.9</td>
</tr>
<tr>
<td>300</td>
<td>7.01</td>
<td>7.12</td>
<td>7.08</td>
<td>7.1</td>
</tr>
<tr>
<td>400</td>
<td>8.23</td>
<td>8.22</td>
<td>8.25</td>
<td>8.2</td>
</tr>
</tbody>
</table>

(i) Before the mass is released, the spring stores energy.

What type of energy does the spring store?

Tick (✓) one box.

- Elastic potential energy
- Gravitational potential energy
- Kinetic energy

(ii) The value of time for the 100 g mass in Test 2 is anomalous.
Suggest two likely causes of this anomalous result.

Tick (✓) two boxes.

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Misread stopwatch</td>
</tr>
<tr>
<td>Pulled the mass down too far</td>
</tr>
<tr>
<td>Timed half oscillations, not complete oscillations</td>
</tr>
<tr>
<td>Timed too few complete oscillations</td>
</tr>
<tr>
<td>Timed too many complete oscillations</td>
</tr>
</tbody>
</table>

(iii) Calculate the correct mean value of time for the 100 g mass in **Table 2**.

Mean value = __________________ s

(iv) Although the raw data in **Table 2** is given to 3 significant figures, the mean values are correctly given to 2 significant figures.

Suggest why.

(v) The student wanted to plot her results on a graph. She thought that four sets of results were not enough.

What extra equipment would she need to get more results?

(Total 17 marks)
A 1 N weight is tied to a 30 cm long piece of elastic. The other end is fixed to the edge of a laboratory bench. The weight is pushed off the bench and bounces up and down on the elastic.

The graph shows the height of the weight above the floor plotted against time, as it bounces up and down and quickly comes to rest.

(a) Mark on the graph a point labelled \( F \), where the weight stops falling freely.

(b) Mark on the graph a point labelled \( S \), where the weight finally comes to rest.

(c) Mark two points on the graph each labelled \( M \), where the weight is momentarily stationary.

(Q22.

(a) The pictures show four objects. Each object has had its shape changed.

(Total 3 marks)
Which of the objects are storing elastic potential energy?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Explain the reason for your choice or choices.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)

(b) A student makes a simple spring balance. To make a scale, the student uses a range of weights. Each weight is put onto the spring and the position of the pointer marked
The graph below shows how increasing the weight made the pointer move further.

(i) Which one of the following is the unit of weight?.

Draw a ring around your answer.

joule  kilogram  newton  watt

(ii) What range of weights did the student use?

(iii) How far does the pointer move when 4 units of weight are on the spring?

(iv) The student ties a stone to the spring. The spring stretches 10 cm.
Q23.

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,

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(b) why the shuttlecock reaches a steady speed.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(Total 5 marks)
Mark schemes

Q1.
(a) (produces) a force from water on the boat in the forward direction
   accept in the opposite direction
   this must refer to the direction of the force not simply the boat moves forwards
   an answer produces an (equal and) opposite force gains 1 mark

(b) (i) 1.5
   allow 1 mark for correct substitution, ie \( \frac{16 - 4}{8} \) or \( \frac{12}{8} \)
   provided no subsequent step shown
   ignore sign
   m/s\(^2\)

(ii) 102
   or their (b)(i) \( \times \) 68 correctly calculated
   allow 1 mark for correct substitution, ie 1.5 \( \times \) 68
   or their (b)(i) \( \times \) 68
   provided no subsequent step shown

(iii) greater than
   reason only scores if greater than chosen
   need to overcome resistance forces
   accept named resistance force
   accept resistance forces act (on the water skier)
   do not accept gravity

Q2.
(a) terminal

(b) 5.4 (kg)
   correct substitution of 54 = \( m \times 10 \) gains 1 mark

(c) (i) 0 < a < 10
   some upward force
accept some drag / air resistance

reduced resultant force

(ii) 0

upward force = weight (gravity)

resultant force zero

Q3.

(a) 750

allow 1 mark for correct substitution, ie 75 × 10 provided no subsequent step shown

newton(s) / N

do not accept n

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist reaches terminal velocity
and
a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain
first terminal velocity

• on leaving the plane the only force acting is weight (downwards)  
  accept gravity for weight throughout  

• as parachutist falls air resistance acts (upwards)  
  accept drag / friction for air resistance
• weight greater than air resistance or resultant force downwards
• (resultant force downwards) so parachutist accelerates
• as velocity / speed increases so does air resistance
• terminal velocity reached when air resistance = weight
  accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity
• opening parachute increases surface area
• opening parachute increases air resistance
• air resistance is greater than weight
• resultant force acts upwards / opposite direction to motion
• parachutist decelerates / slows down
• the lower velocity means a reduced air resistance
  air resistance and weight become equal but at a lower (terminal) velocity

(c) (i) any one from:
• mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling) clay
• material parachute made from
  accept same (plastic) bag
• number / length of strings

(ii) C
  reason only scores if C is chosen
  smallest (area) so falls fastest (so taking least time)
  accept quickest/quicker for fastest
  if A is chosen with the reason given as ‘the largest area so falls slowest’ this gains 1 mark

Q4.
(a) gravity
  accept weight
  do not accept mass
  accept gravitational pull
(b) (i) Initially force $L$ greater than force $M$
   accept there is a resultant force downwards
   (as speed increases) force $M$ increases
   accept the resultant force decreases
   when $M = L$, (speed is constant)
   accept resultant force is 0
   accept gravity/weighty for $L$
   accept drag/ upthrust/resistance/friction for $M$
   do not accept air resistance for $M$ but penalise only once
   (ii) terminal velocity
   (iii) 0.15
   accept an answer between 0.14 – 0.16
   an answer of 0.1 gains no credit
   allow 1 mark for showing correct use of the graph

Q5.
(a) (i) friction
   accept any way of indicating the correct answer
   (ii) gravity
   accept any way of indicating the correct answer

(b) (i) accelerates or speed / velocity increases
   accept faster and faster (1 mark)
   do not accept faster pace / falls faster
   or suggestions of a greater but constant speed
   downwards / falls
   accept towards the Earth / ground
   this may score in part (b)(ii) if it does not score here and
   there is no contradiction between the two parts
   (ii) constant speed / velocity or terminal velocity / speed or zero acceleration
   stays in the same place negates credit

Q6.
(a) (i) distance vehicle travels during driver’s reaction time
   accept distance vehicle travels while driver reacts
(ii) any two from:

- tiredness
- (drinking) alcohol
- (taking) drugs
- speed
- age
  accept as an alternative factor distractions, eg using a mobile phone

(b) (i) 320 000

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

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

(iii) 40

or

their (b)(ii) correctly calculated
allow 1 mark for statement work done = KE lost
or
allow 1 mark for correct substitution, ie
\( 8000 \times \text{distance} = 320 000 \) or their (b)(ii)

(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

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

\textbf{do not} accept friction between road and tyres / wheels

(causes) decrease in KE and increase in thermal energy
accept heat for thermal energy accept
KE transferred to thermal energy
(c) the battery needs recharging less often
   accept car for battery

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

the decrease in (kinetic) energy / work done charges the battery (up)
accept because not all work done / (kinetic) energy is wasted

Q7.

(a) 96 (m)

(b) (i) similar shape curve drawn above existing line going through (0,0)
   allow 1 mark for any upward smooth curve or straight
   upward line above existing line going through (0,0)

(ii) Rain on the road

(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

(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

Q8.

(a) increases

increases

(b) 23 (m)

accept 43 circled for 1 mark
accept 9 + 14 for 1 mark

(c) (i) all points correctly plotted

- all to ± 1/2 small square
- one error = 1 mark
- two or more errors = 0 marks

line of best fit

(ii) correct value from their graph (± 1/2 small square)

(d) (i) 70

½ × 35 × 4 gains 2 marks

attempt to estimate area under the graph for 1 mark

(ii) line from (0.6,35)

- sloping downwards with a less steep line than the first line

- cutting time axis at time > 4.6 s

- accept cutting x-axis at 6

(e) (i) 42 000

1200 × 35 gains 1 mark

kgm / s

Ns

(ii) 10 500 (N)

42 000 / 4 gains 1 mark

alternatively:

a = 35 / 4 = 8.75 m / s²
Q9.

(a) the distance travelled under the braking force

(b) the reaction time will increase

increasing the thinking distance (and so increasing stopping distance)

(increases stopping distance is insufficient)

(c) No, because although when the speed increases the thinking distance increases by the same factor the braking distance does not.

eg

increasing from 10 m/s to 20 m/s increases thinking distance from 6 m to 12 m but the braking distance increases from 6 m to 24 m

(d) If the sled accelerates the value for the constant of friction will be wrong.

(e) only a (the horizontal) component of the force would be pulling the sled forward

the vertical component of the force (effectively) lifts the sled reducing the force of the surface on the sled

(f) \[-u^2 = 2 \times -7.2 \times 22\]

award this mark even with 0² and/or the negative sign missing

\[u = 17.7(99)\]

allow 17.7(99) then incorrectly rounded to 17 for 2 marks

Q10.

(a) time

correct order only

(b) The car tyres being badly worn
(c) (i) braking distance increases with speed
   accept positive correlation
   do not accept stopping distance for braking distance
   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 \( \times 4 \)

(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

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

(ii) (on the reduced speed limit roads) over the same period of time
     accept a specific time, eg 1 year
     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

Q11.

(a) evidence of
   \( \frac{\text{change in speed}}{\text{time taken}} \) or \( \frac{40}{5} \)
   gains 1 mark
   (credit 50/10 or 5 with 1 mark) NOT 40/10 or 50/5
   but 8 [N.B. negative not required]
   gains 2 marks
   units metres per second per second or (metres per second squared or m/s²)
   for 1 mark

(b) (i) idea that
    accelerates at first due to gravity
    air/wind resistance
    friction/resistance/drag with air increases with speed
    eventually gravity and friction cancel balance
    or (no net/accelerating force) [NOT terminal velocity]
each for 1 mark

(ii) idea
a bigger resistance/friction/drag at any given speed (credit a bigger drag (factor))
for 1 mark

(c) evidence of \( \times 10 \times 9.8 \times 9.81 \) or 750/735(75)
for 1 mark

Q12.

(a) (i) 3000 N

(ii) air resistance

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

(ii) the area under the graph

(iii) horizontal line above previous one

for the same time

sloping line cutting time axis before previous line

\[ eg \]

\[ 0 \]

\[ T i m e \ t \]

\[ V e l o c i t y \]

(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 refer to the information on page 5 and 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.

Q13.
(a) (i) air resistance/drag/friction (or upthrust) weight/gravitational pull/gravity

    for 1 mark each

    1

(ii) air resistance/friction acts in opposite direction to motion

    1

(iii) Y

    1

(iv) the sky-diver accelerates/his speed increases in downward direction/towards the Earth/falls

    for 1 mark each

    2

(b) force X has increased force Y has stayed the same the speed of the sky-diver will stay the same

    for 1 mark each

    3

(c) (i) CD

    1

(ii) 500

    1

(iii) 50

    \{but apply e.s.f. from (i)}
Q14. (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 \times 8

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

2

(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]

Q15. (a) momentum before (jumping) = momentum after (jumping) accept momentum (of the skateboard and skateboarder) is conserved 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*

(b) 7

*accept −7 for 3 marks*

*allow 2 marks for momentum of skateboarder equals 12.6*

*or*

\[ 0 = 42 \times 0.3 + (1.8 \times −v) \]

*or*

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

Q16.

(a) (i) \( 0.15 \times 0.08 = 0.012 \)

(ii) kg m/s

(iii) equal to

(b) momentum of the air increases

*or*

force backwards increases

*accept air moves faster*

*accept momentum backwards increases*

*accept pushes more air back(wards)*

so momentum of the toy must increase

*or*

the force forwards (on the toy) increases

*accept momentum forwards must increase*

*it = toy*

Q17.

(a) speed

*must be in correct order*

direction

(b)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Scalar</th>
<th>Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Q18.

(a) Zero / 0

Accept none
Nothing is insufficient

velocity / speed = 0

accept it is not moving
paintball has not been fired is insufficient

(b) 0.27
allow 1 mark for correct substitution, ie $p = 0.003(0) \times 90$
provided no subsequent step

(c) equal to

Q19.
(a) (i) distance travelled under the braking force

Accept distance travelled between applying the brakes and stopping

(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

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

must mention both speed and force

(b) 22.5

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

or

for showing e.g. $90 \div 4$

an answer 17 gains 1 mark

any answer such as 17.4 or 17.5 scores 0

(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

(ii) 5

allow 2 marks for correctly obtaining momentum before as 12 000

or

allow 2 marks for

$1500 \times 8 = 2400 \times v$

or

allow 1 mark for a relevant statement re conservation of
momentum

or

allow 1 mark for momentum before = 1500 × 8

(d) the seat belt stretches
driver takes a longer (impact) time to slow down and stop (than a driver hitting a hard surface / windscreen / steering wheel)

for the (same) change of momentum
accept so smaller deceleration / negative acceleration

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

Q20.

(a) (i) any two from:
• length of coils increased
• coils have tilted
• length of loop(s) increased
• increased gap between coils
• spring has stretched / got longer
• spring has got thinner

(ii) remove mass
accept remove force / weight

observe if the spring returns to its original length / shape (then it is behaving elastically)

(b) (i) 8.0 (cm)
extension is directly proportional to force (up to 4 N)
for every 1.0 N extension increases by 4.0 cm (up to 4 N)
evidence of processing figures eg 8.0 cm is half way between 4.0 cm and 12.0 cm

allow spring constant (k) goes from to \( \frac{1}{4} \) to \( \frac{5}{22} \)

(ii) any value greater than 4.0 N and less than or equal to 5.0 N

the increase in extension is greater than 4 cm per 1.0 N (of force) added dependent on first mark

(c) (i) elastic potential energy

(ii) misread stopwatch

timed too many complete oscillations

(iii) 4.3 (s)

accept 4.33 (s)

(iv) stopwatch reads to 0.01 s

reaction time is about 0.2 s

or

reaction time is less precise than stopwatch

(v) use more masses

smaller masses eg 50 g

not exceeding limit of proportionality

Q21.

(a) \( F \) 50 cm on first part of graph

\( \text{tolerance} + \text{ or } - 3cm \)

(b) \( S \) at the far right

\( \text{credit anywhere to right of last trough} \)

(c) \( M \) on any two tops of peaks or bottoms of troughs

both are required for the mark M needs to be central to the trough or peak, except if \( F \) is in the way in one case

Q22.
(a) B or bungee cords

C or springs or playground ride

*each additional answer loses 1 mark minimum mark zero*

will go back to original shape/size

(b) (i) newton

(ii) \(0 - 5 \text{ (N)}\) or 5

*accept\(1 - 5 \text{ (N)}\)*

*do not* accept 4

(iii) 16 cm

(iv) 2.5 (N)

*accept answer between 2.4 and 2.6 inclusive*

---

**Q23.**

(a) reference to

* weight / force of gravity / acting downwards

* unbalanced (by any upwards force)

*for 1 mark each*

(b) *ideas that forces balance(d)*

* gains 1 mark*

*but*

weight / force of gravity / downwards force balanced by friction / air resistance / drag / upwards force

*gains 2 marks*

latter increases with speed

*accept arrows or relevant length and direction if clearly labelled, as answers to parts (a) and (b))*

*for 1 further mark*