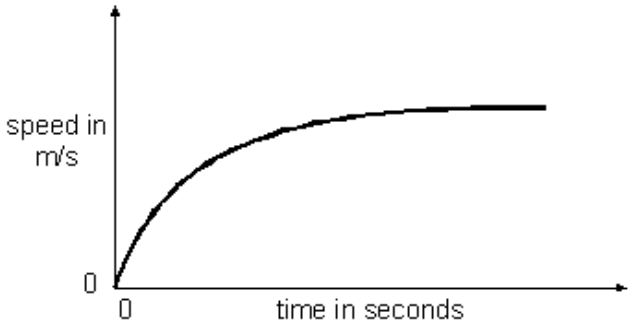
7.3.9 Unbalanced forces

77 minutes

116 marks

Q1. The graph shows the results of a test in which a car accelerates to its maximum speed.



(a) (i) Describe how the acceleration of the car changes after the car has started to move.

.....

.....

1 mark

(ii) How does the **resultant** force on the car change?

.....

.....

1 mark

The car has a mass of 1000 kg and the maximum forward force on the car, produced by the engine, is 4000 N.

It is claimed that the car will accelerate from 0 to 24 m/s in 6 seconds.

(b) Use calculations, with the correct units, to show that the claim is false.

.....

.....

.....

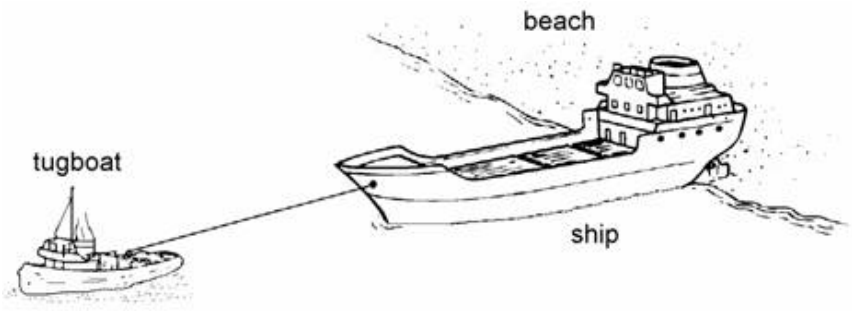
.....

.....

3 marks
Maximum 5 marks

##

In a storm, a small ship was blown onto a beach. Now it is calm and there is no wind. A tugboat is trying to pull the ship off the beach.



(a) The tugboat pulls the ship with a force of 25 000 N.

The ship does not move because of the force of friction acting on it.

(i) Tick **one** box to show the size of the frictional force acting on the ship.

zero	☐
more than zero but less than 25 000 N	☐
25 000 N	☐
more than 25 000 N	☐

1 mark

(ii) Add an arrow to the drawing to show the direction of the frictional force acting on the ship.

1 mark

(b) When the tide is higher, the tugboat again pulls the ship with a steady force of 25 000 N. The ship begins to move.

Once the ship is off the beach, the tugboat continues to pull the ship with a force of 25 000 N.
A frictional force due to the water acts on the ship.

(i) At first, the speed of the ship increases.

Tick **one** box to describe the frictional force acting on the ship while its speed is increasing.

- zero ☐
- more than zero but less than 25 000 N ☐
- 25 000 N ☐
- more than 25 000 N ☐

1 mark

(ii) After a short while, the ship reaches a steady speed. The tugboat continues to pull with a force of 25 000 N.

Tick **one** box to describe the frictional force acting on the ship while it is going at a steady speed.

- zero ☐
- more than zero but less than 25 000 N ☐
- 25 000 N ☐
- more than 25 000 N ☐

1 mark

(iii) The ship is towed to the north. What is the direction of the frictional force acting on the ship?

.....

1 mark
Maximum 5 marks

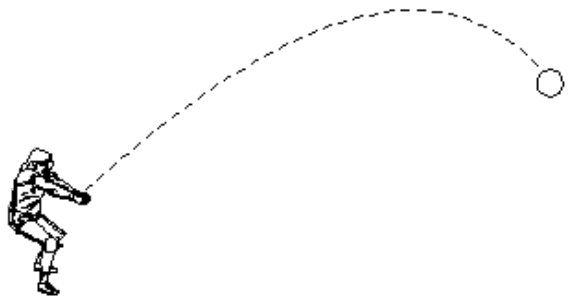
Q3. (a) Some of the statements in the list describe forces, and some do not.

Tick the boxes by the **three** forces.

the movement of a car travelling along a road	☐
the push of a jet engine on an aeroplane.	☐
the flow of electricity through a light bulb.	☐
the weight of a book on a table.	☐
the pull of a horse pulling a cart.	☐
the speed of a hockey ball flying through the air.	☐

3 marks

(b) A girl throws a ball. The diagram shows the path of the ball after she has thrown it.



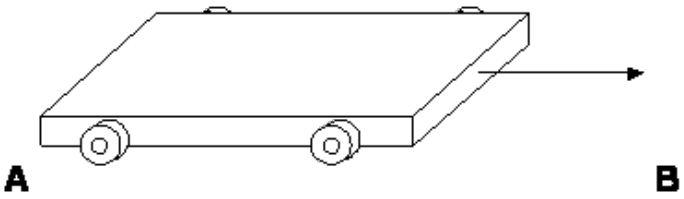
How can you tell from the **path** of the ball that there is a force acting on the ball?

.....

.....

1 mark

(c)



The drawing shows a trolley rolling along a table from **A** to **B**.
Then another force acts on the trolley. This is shown by the arrow on the drawing.

What effect does this force have?

Tick the correct box.

It makes the trolley go faster. ☐

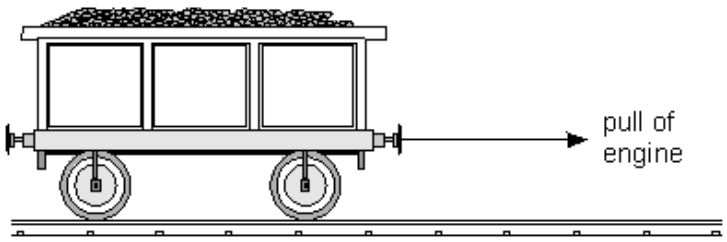
It makes the trolley go slower. ☐

It makes the trolley change direction. ☐

It has no effect. ☐

1 mark
Maximum 5 marks

Q4.



(a) A railway engine is being used to try to pull a wagon along a level track. The wagon's brakes are on, and the wagon does not move.

(i) Draw **one** arrow on the diagram to show the direction of the force which prevents the wagon from moving.

1 mark

(ii) Is the force which prevents the wagon from moving **greater than**, **equal to** or **less than** the pull of the engine?

.....

1 mark

(b) (i) When the wagon's brakes are off, the engine pulls the wagon forwards. A frictional force also acts on the wagon. In what direction does the frictional force act?

1 mark

(ii) The pull of the engine is 5000 N. When the wagon's speed is increasing, how large is the frictional force?
Tick the correct box.

zero ☐

between 0 and 5000 N ☐

5000 N ☐

more than 5000 N ☐

1 mark

(c) After a while, the wagon travels at a steady speed. The engine is still pulling with a force of 5000 N.

How large is the frictional force now?
Tick the correct box.

zero ☐

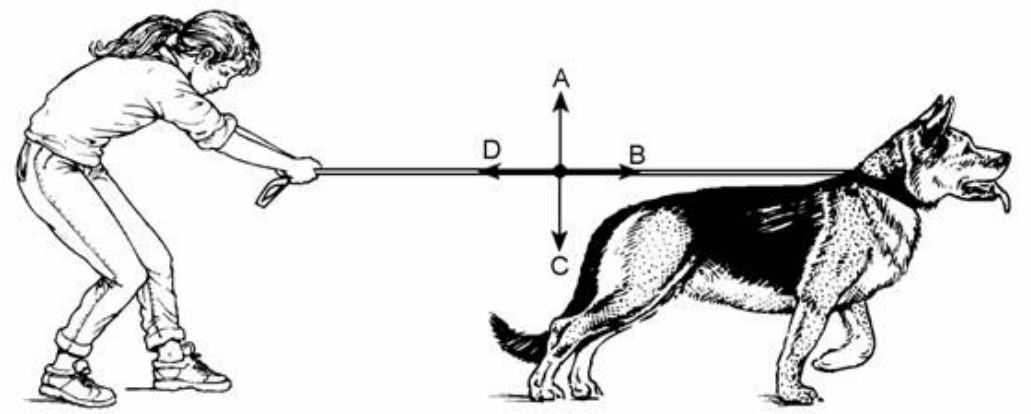
between 0 and 5000 N ☐

5000 N ☐

more than 5000 N ☐

1 mark
Maximum 5 marks

Q5.



(a) Megan's dog is pulling on his lead.
Which arrow, A, B, C or D, shows the direction of this force?
Give the letter.

.....

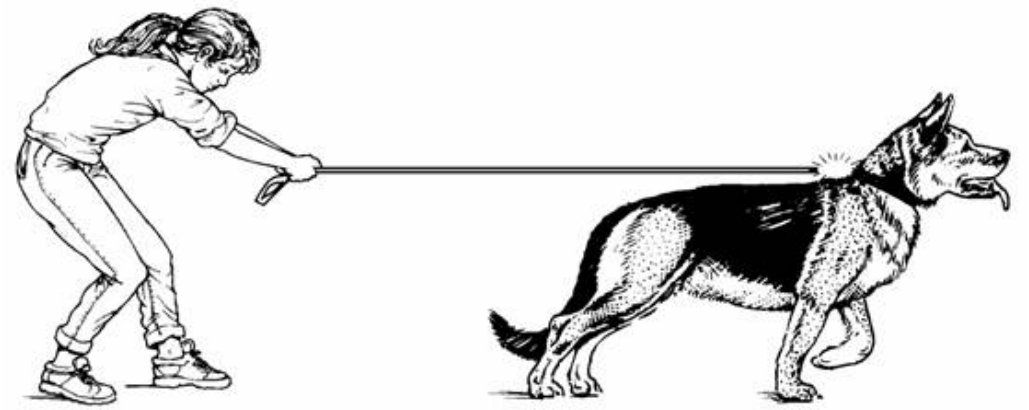
1 mark

(b) Megan has to pull to keep the dog still.
Which arrow shows the direction of this force? Give the letter.

.....

1 mark

(c) Suddenly the dog's collar breaks.



(i) When the collar breaks, the lead moves.
Draw an arrow on the diagram to show which way the lead starts to move.

1 mark

(ii) Why does the lead move when the collar breaks?

.....

.....

1 mark
Maximum 4 marks

Q6. (a) The diagram shows two bar magnets.

The north pole and south pole are shown on magnet A. The poles are not shown on magnet B.

Describe an experiment you could do, using magnet A, to find which end of magnet B is the north pole **and** which is the south pole.

.....

.....

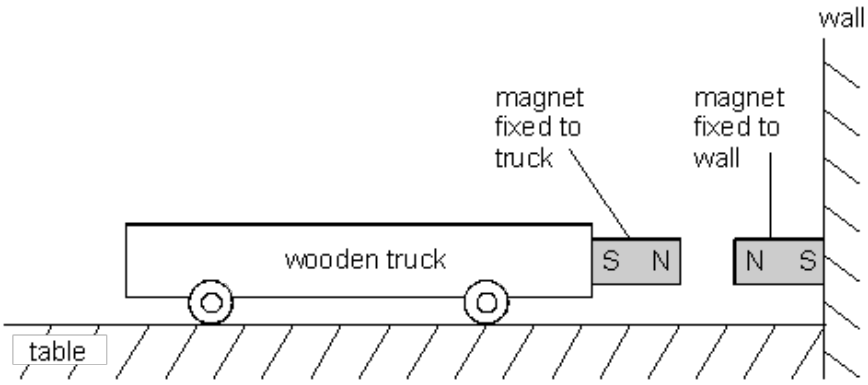
.....

.....

.....

3 marks

(b) The diagram shows a wooden truck near a wall. There is a strong magnet fixed to the wall and a strong magnet fixed to the front of the wooden truck.



James holds the wooden truck so that it does not move.
Then he lets go of the wooden truck. In which direction will it move?

.....

1 mark

(c) James removes the magnet from the wooden truck. He gives the truck a push so that it rolls along the table.

What effect will friction have on the speed of the truck as it rolls along?

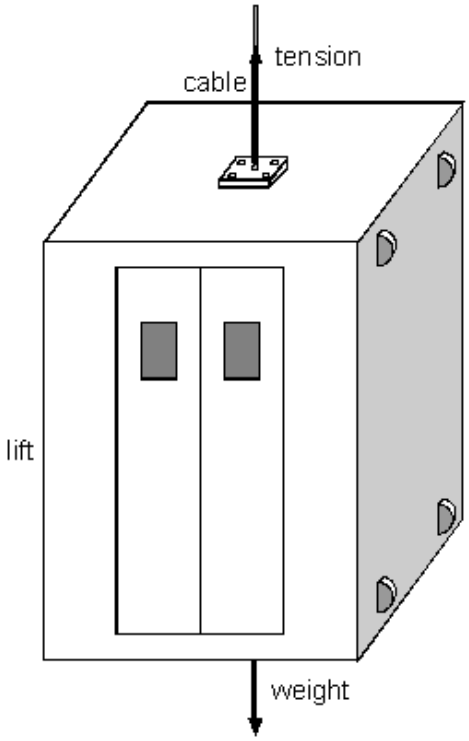
.....

.....

1 mark
Maximum 5 marks

##

The lift in a tall building hangs from a strong cable. The movement of the lift is affected by only two forces.
These forces are the **tension** in the cable and the **weight** of the lift.



(a) The lift is **not** moving. How do the sizes of the two forces compare?
Tick the correct box.

The tension is greater than the weight.	☐
The tension equals the weight.	☐
The tension is less than the weight.	☐
It is impossible to know which is greater.	☐

1 mark

(b) When the lift is moving upwards and its speed is increasing, how do the sizes of the two forces compare?

.....

1 mark

(c) When the lift is moving upwards at a constant speed, how do the sizes of the two forces compare?

.....

1 mark

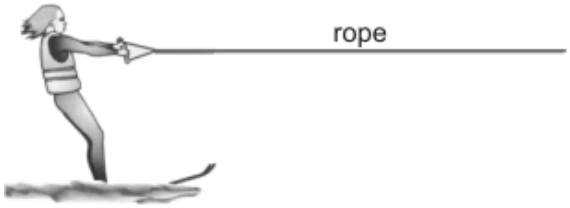
(d) Near the top of the building the lift is moving upwards, but slowing down. How do the sizes of the two forces now compare?

.....

1 mark

Maximum 4 marks

Q8. The drawing shows Amy water-skiing.



(a) (i) The rope is pulling Amy. Draw an arrow on the rope to show the direction of this force.
Label the arrow A.

1 mark

(ii) Draw an arrow to show the direction of Amy's weight.
Label the arrow B.

1 mark

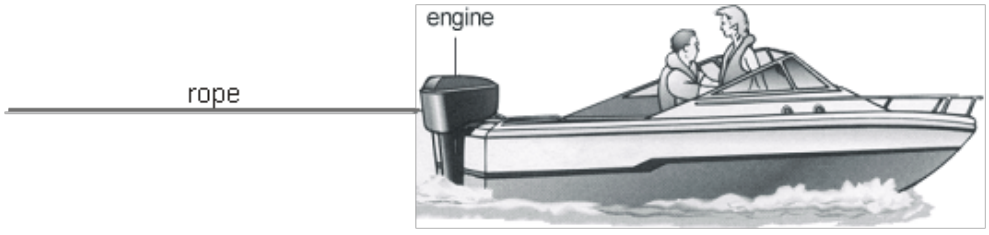
(b) Give the names of **two** other forces which act on Amy or on her skis.

1. .....

2. .....

2 marks

The drawing below shows the speed boat which is pulling Amy along.



(c) The rope which pulls Amy also exerts a force on the boat.
Draw an arrow on the rope to show the direction of this force.
Label the arrow C.

1 mark

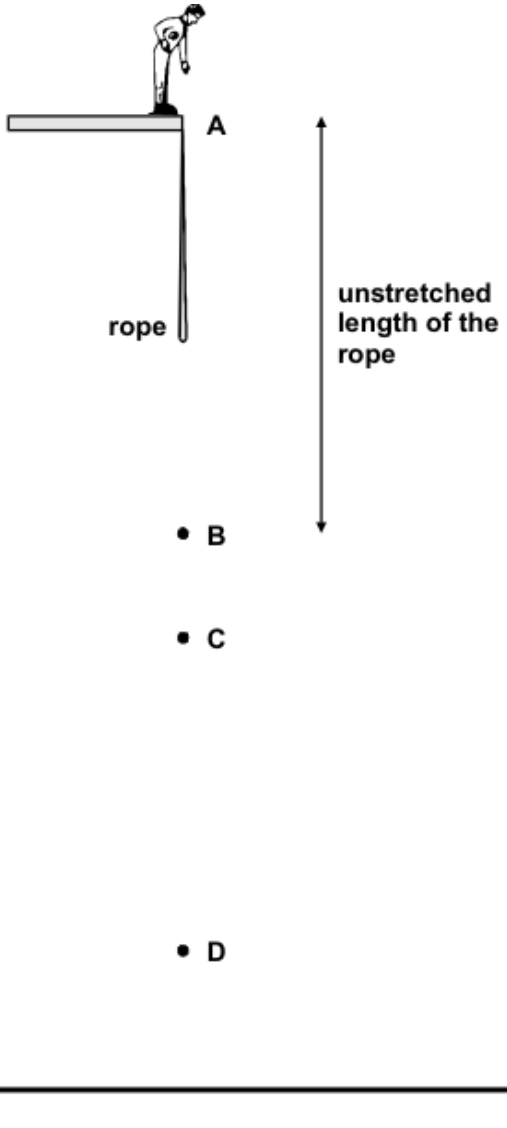
(d) The force of the engine on the boat is increased.
What effect will this have on the speed of the boat?

……..……..

1 mark
Maximum 6 marks

##

A man does a 'bungee jump' over a lake. He jumps from point A with an elasticated rope tied to his ankles. The rope reaches down to point B when it is not being stretched.



The man falls past B, and the rope begins to stretch. He falls past point C to point D, which is the lowest point he reaches. Then he begins to move upwards again. Eventually he comes to rest at point C.

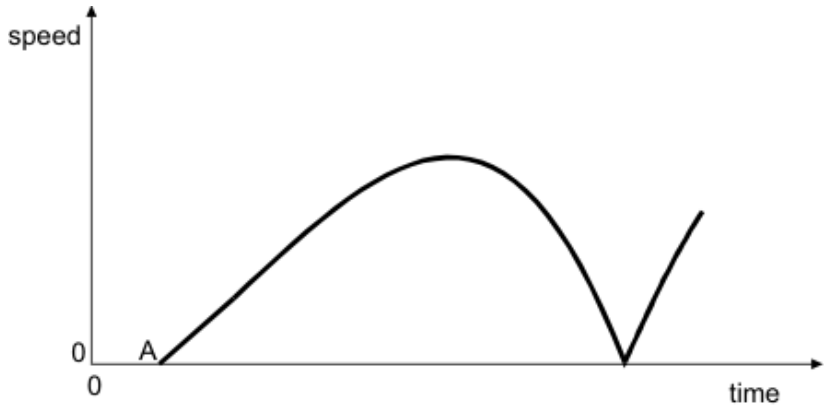
(a) (i) At which point, A, B, C or D, is the man when the tension in the rope is greater than his weight? .....

1 mark

(ii) At which point, A, B, C or D, is the man when the tension in the rope is equal to his weight? .....

1 mark

(b) The graph shows how the man's speed varies with time as he falls from point A to point D and bounces back upwards.



The point when the man jumped from A has been labelled on the curve.
Label the points on the curve when the man was at points B, C and D as he fell.

3 marks

(c) The total energy of the man and the rope includes the man's potential energy, his kinetic energy, and the elastic (strain) energy stored in the stretched rope.

Describe how the elastic (strain) energy in the rope changes as the man falls from point A to point D.

.....

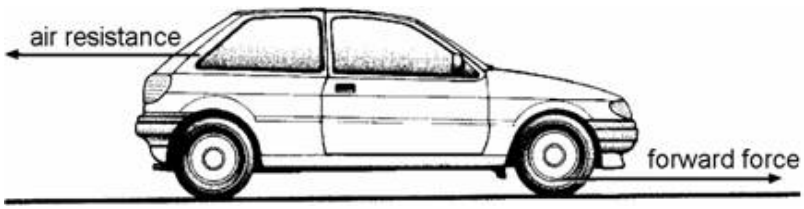
.....

.....

.....

2 marks
Maximum 7 marks

Q10. When a car is being driven along, two horizontal forces affect its motion. One is air resistance and the other is the forward force.



(a) (i) Explain how molecules in the air cause air resistance.

.....

.....

1 mark

(ii) Explain why air resistance is larger when the car is travelling faster.

.....

.....

1 mark

(b) (i) Compare the sizes of the forward force and the air resistance when the car is speeding up.

The forward force is .....

.....

1 mark

(ii) Compare the sizes of the two forces while the car is moving at a steady 30 miles per hour.

The forward force is .....

.....

1 mark

(c) The forward force has to be larger when the car is travelling at a steady 60 mph than when it is travelling at a steady 30 mph. Why is this?

.....

.....

1 mark

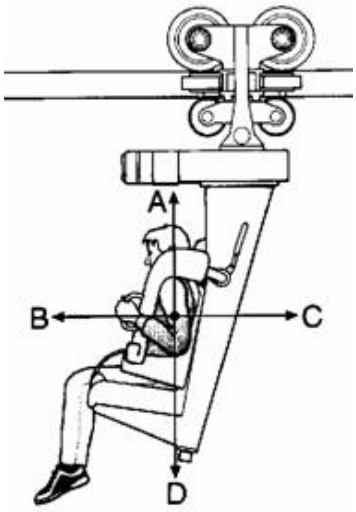
(d) The forward force is the result of the tyres **not** being able to spin on the road surface. What is the name of the force that stops the tyres spinning?

.....

1 mark

Maximum 6 marks

Q11. (a) The diagram shows Alan sitting on a ride at a theme park.



(i) Which arrow shows Alan's weight?

Give the correct letter. .....

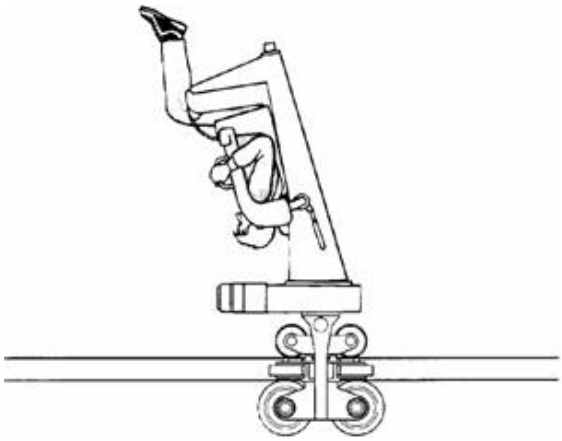
1 mark

(ii) Alan begins to move forwards. Which arrow shows the force which makes Alan move faster?

Give the correct letter. .....

1 mark

(b) During the ride, Alan is upside down.

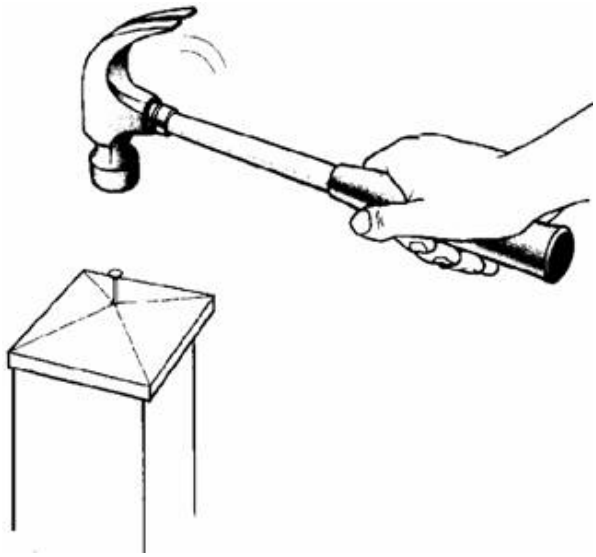


Draw an arrow on the diagram to show the direction of Alan's weight while he is upside down.

1 mark

Maximum 3 marks

Q12. A man was hammering nails into a wooden fence post.
The drawing shows the hammer just before it hit a nail.



(a) The hammer hit the nail. What is the direction of the force of the hammer on the nail?
Draw an arrow on the diagram to show this.

1 mark

(b) What effect did this force have on the nail?

.....

1 mark

(c) How did the speed of the hammer change when the hammer hit the nail?

.....

1 mark

(d) The hammer hit the nail again. The hammer was moving faster this time.
The size of the force of the hammer on the nail was different.
In what way was it different?

.....

1 mark

(e) Mark could see the man mending the fence. The man was at the other end of a large field. Mark saw the man hit a nail with the hammer. One second later he heard the sound.

Why did Mark hear the sound **after** he saw the hammer hit the nail?

.....

.....

1 mark

(f) Mark walked half way across the field, nearer to the man. Again he saw the hammer hit a nail, then heard the sound.

This time, how long was the gap between seeing and hearing the hammer hit the nail?

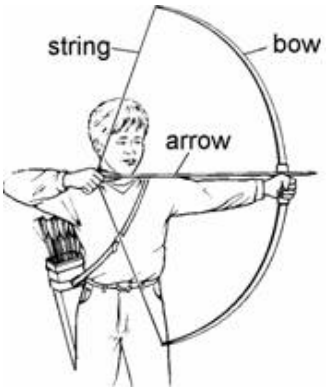
Tick the correct box.

longer than one second	☐
one second	☐
less than one second	☐
there was no gap	☐

1 mark
Maximum 6 marks

##

The drawing shows a boy with a bow and arrow. He is holding the **arrow** and pulling it back.



(a) Two horizontal forces act on the arrow. These are the force exerted by the boy's hand and the force exerted by the string. The arrow is **not** moving.

The boy pulls the arrow with a force of 150 N. What is the size of the force exerted by the string on the arrow?

..... N

1 mark

(b) When the boy lets go of the arrow, it starts to move forward.

Explain why it starts to move.

.....

.....

1 mark

(c) The arrow flies across a field and hits a target.

Two forces act on the arrow while it is in the air. Air resistance acts in the opposite direction to the movement, and gravity acts downwards. These two forces **cannot** balance each other, even when they are the same size. Why is this?

.....

.....

1 mark

(d) The arrow has a sharp pointed end. When the arrow hits the target, the sharp point exerts a very large pressure on the target.

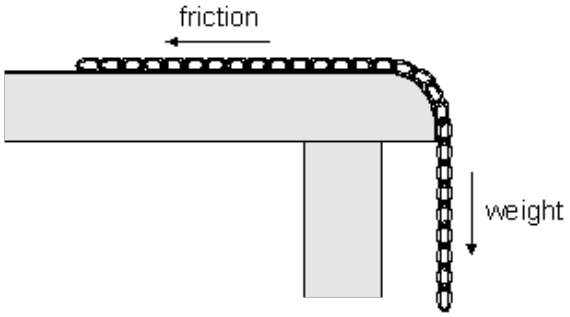
Why does a sharp pointed end exert a larger pressure than a blunt end?

.....

.....

1 mark
Maximum 4 marks

Q14. The diagram shows a chain hanging down over the edge of a table.



Two of the forces on the chain are:

- the weight of the part of the chain which is hanging over the edge;
- friction between the chain and the table.

(a) The chain is **not** moving. What does this tell you about these two forces acting on the chain?

1 mark

(b) The chain is moved slightly to the right. It begins to slide off the table.

(i) What does this tell you about these two forces now?

……..……

1 mark

(ii) Describe how the size of each force changes as the chain slides off the table.

- weight of the part of the chain hanging over the edge ……

  ……..……..…….....

- friction between the chain and the table ……

  ……..……..…….....

2 marks

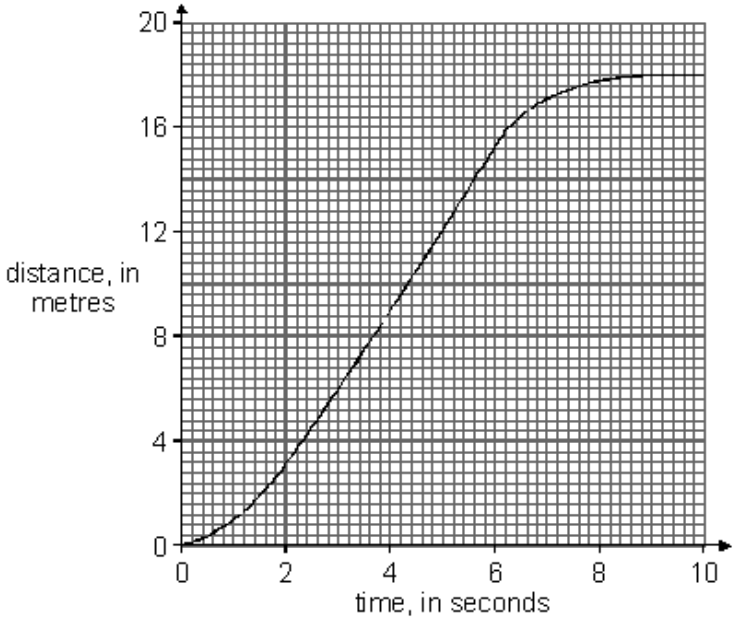
(iii) How does the speed of the chain change as it slides off the table?

……..……

……..……

1 mark
Maximum 5 marks

Q15. A remote-controlled car was timed over a period of 10 seconds.
A graph of **distance** against **time** is shown below.



(a) Describe the motion of the car between:

(i) 2 seconds and 6 seconds;

.....

1 mark

(ii) 9 seconds and 10 seconds.

.....

1 mark

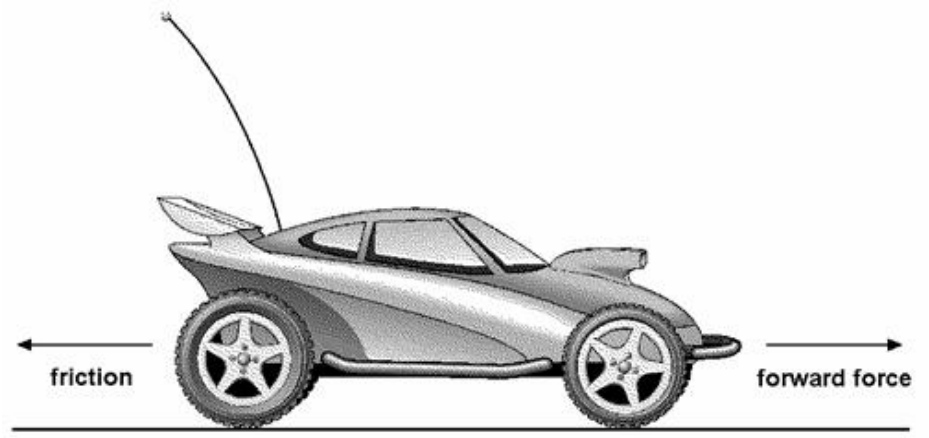
(b) Calculate the average speed of the car between 0 and 10 seconds.
Give the unit.

.....

.....

2 marks

(c) The diagram below shows **two** of the forces acting on the car when it is moving.



(i) When the motor was switched off, the car slowed down and then stopped.

While the car was slowing down, which of the following was true? Tick the correct box.

Friction was zero and the forward force was greater than zero.	☐
The forward force was zero and friction was greater than zero.	☐
Friction was zero and the forward force was zero.	☐
The forward force and friction were both greater than zero.	☐

1 mark

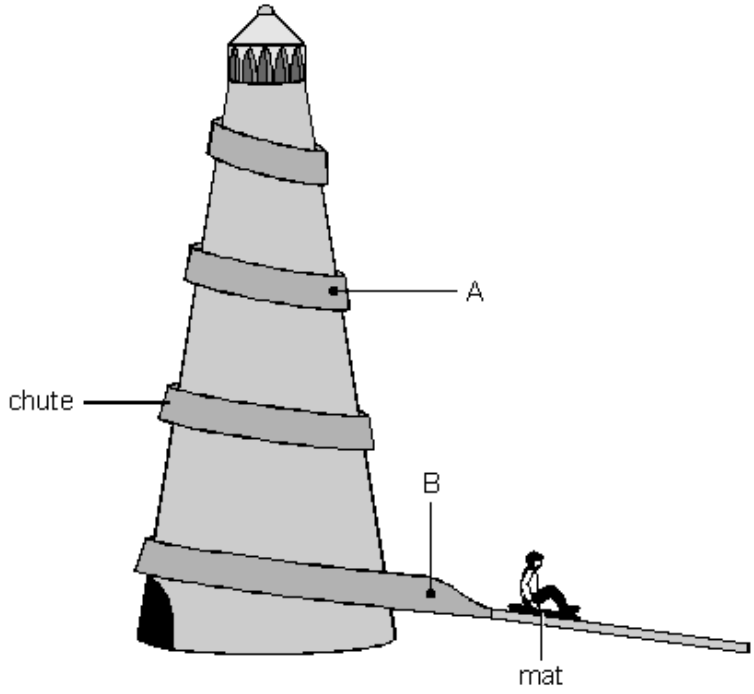
(ii) Use the graph to find the time when the car started to slow down.

The car started to slow down after ..... s.

1 mark
Maximum 6 marks

##

Anil sits on a mat at the top of a helter-skelter and then slides down a chute around the outside.



(a) (i) Name **two** of the forces acting on Anil as he slides from point A to point B.

1. .....

2. .....

2 marks

(ii) As Anil slides from point A to point B, the forces acting on him are balanced.

Describe Anil's speed when the forces acting on him are balanced.

.....

1 mark

(b) Anil goes back for a second go. This time he sits on a smooth cushion instead of a mat.

He goes much faster on the cushion. Give the reason for this.

.....

1 mark

(c) On his third go Anil lies back on the cushion with his arms by his side.

What happens to his speed? Give the reason for your answer.

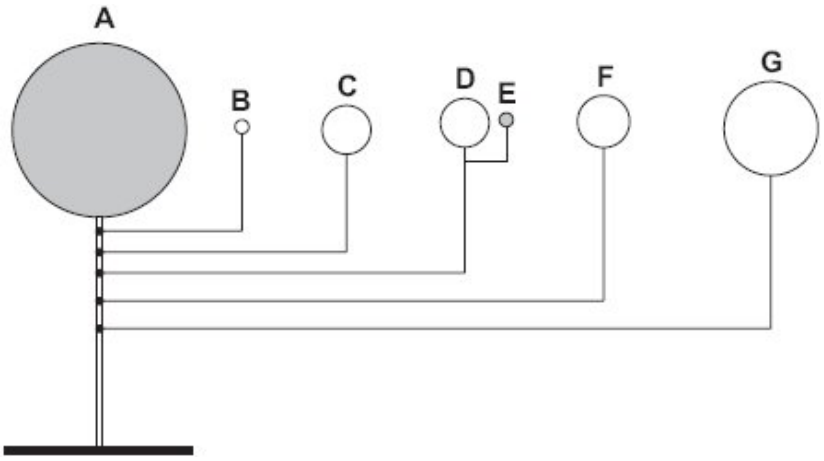
.....

.....

.....

2 marks
Maximum 6 marks

Q17. (a) Alfie made a model of part of the solar system.
He used metal balls for the Sun, the Moon and the planets.



- E goes around D.
- B, C, D, F and G go around A.

Give the letter that is used to label:

(i) the model Sun;

.....

1 mark

(ii) the model Earth;

.....

1 mark

(iii) the model Moon;

.....

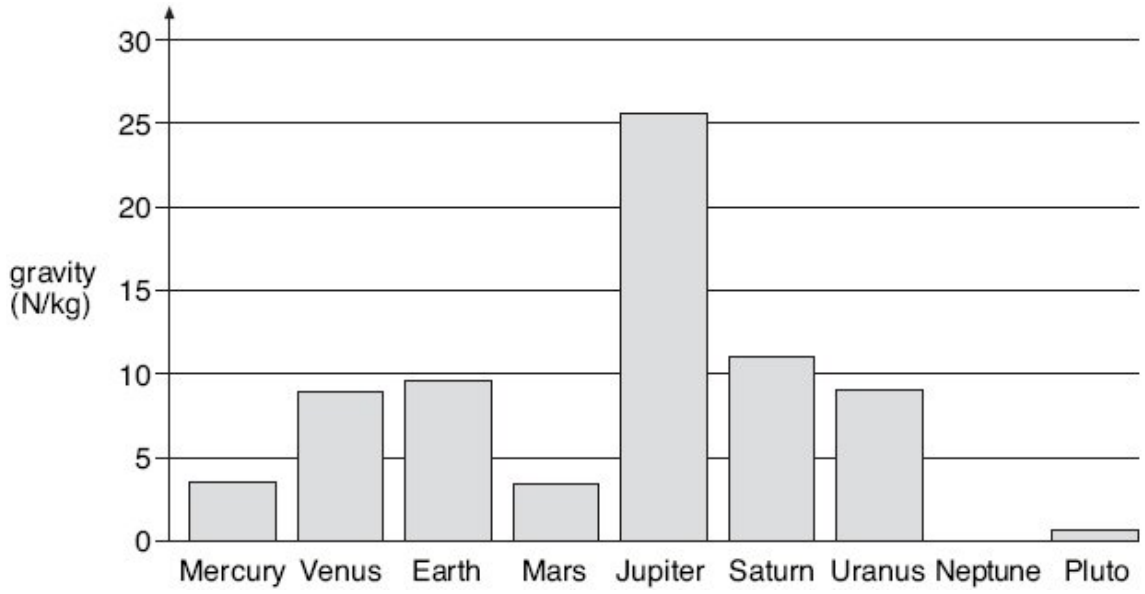
1 mark

(iv) the model planet with the largest orbit.

.....

1 mark

(b) The bar chart shows the force of gravity on eight of the planets.



(i) The gravity on Neptune is 12 N/kg.

On the chart above, draw a bar for the planet Neptune.
Use a ruler.

1 mark

(ii) Give the name of a planet where you would weigh more than you weigh on Earth.

.....

1 mark

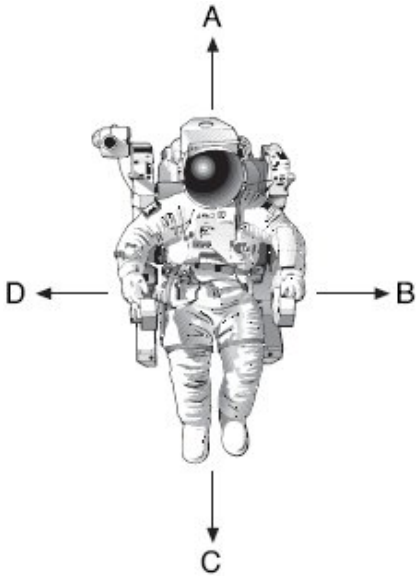
(iii) On which planet would a spaceship need the largest force to take off?

.....

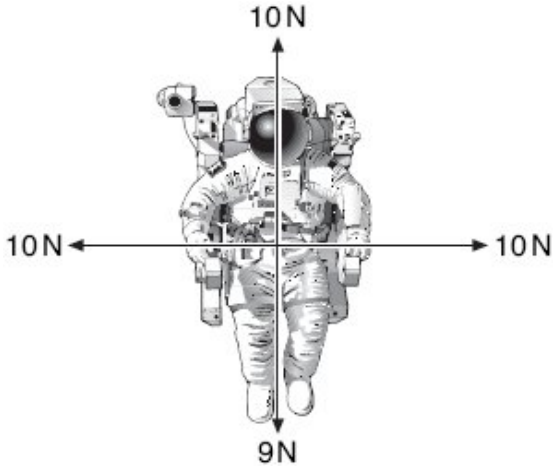
1 mark

maximum 7 marks

Q18. The drawing below shows an astronaut in space.
He has four small jets attached to his space suit.
These jets produce forces on the **astronaut** in the directions A, B, C and D.



(a) The drawing below shows the size and direction of four forces acting on the astronaut.



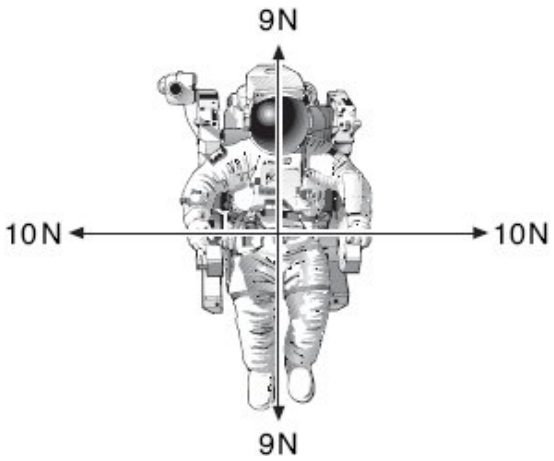
In which direction, A, B, C or D, will the astronaut move?

Give the letter.

.....

1 mark

(b) The drawing below shows the size and direction of four different forces acting on the astronaut.



What will happen to the astronaut when the jets produce these four forces?

.....

1 mark

Explain your answer.

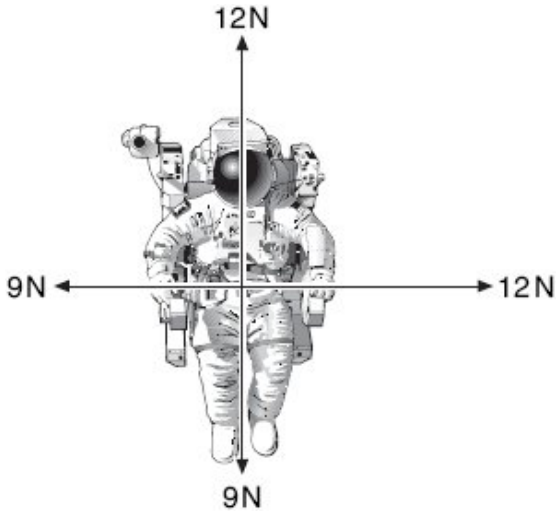
.....

.....

1 mark

(c) The drawing below shows the size and direction of four different forces acting on the astronaut.

Draw an arrow on the diagram below to show the direction in which he will move.



1 mark

maximum 4 marks

Q19. Tom is doing a bungee jump from a bridge.

He is attached to one end of an elastic rope.
The other end of the rope is attached to the bridge.
Tom jumps from the bridge.

(a) (i) What force makes Tom fall towards the ground?

.....

1 mark

(ii) Tom does **not** hit the river below the bridge.
What makes Tom stop falling before he hits the river?

.....

1 mark

(b) The next person to do a bungee jump is Jill.

Jill weighs less than Tom.
Complete the sentence below using words from the box.

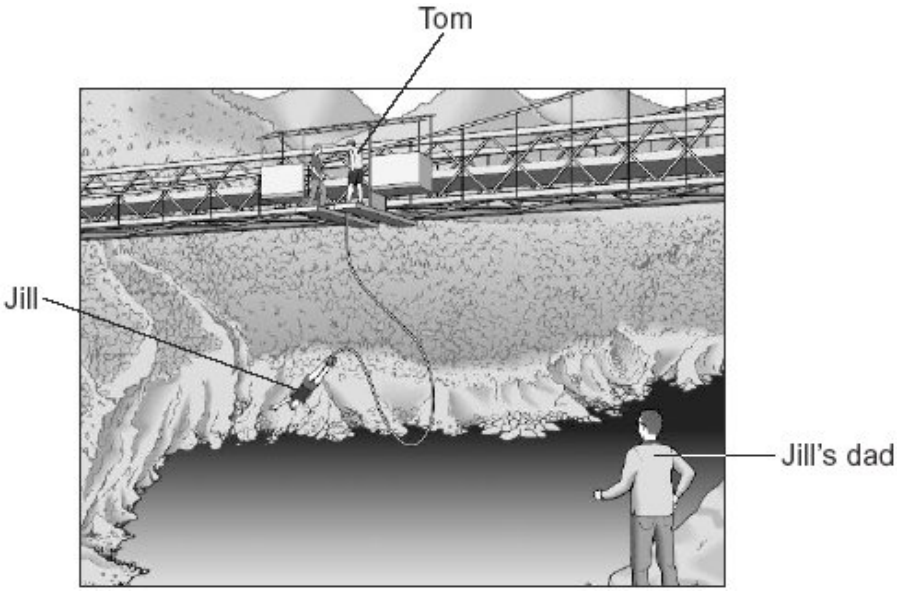
more than	**less than**	**the same as**

When Jill jumps, the rope will stretch .....

it did when Tom jumped.

1 mark

(c) Jill's dad watches her doing the bungee jump.
He is standing a long way from the bridge.
Jill shouts 'bungee' at the same time as she jumps off the bridge.
Jill's dad sees her jump before he hears her shout.



2

(i) Why does Jill's dad **see** her jump before he **hears** her shout?

.....

.....

1 mark

(ii) Tom is near Jill when she shouts. Her dad is far away.

Complete the sentence to describe how the shout will sound to Tom compared with Jill's dad. Use one word from the box.

louder	**higher**	**lower**	**quieter**

The shout will sound ..... to Tom.

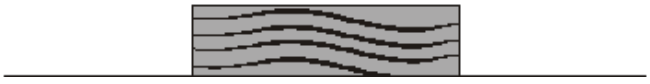
1 mark

(iii) What part of Tom's ear vibrates when he hears Jill shout?

.....

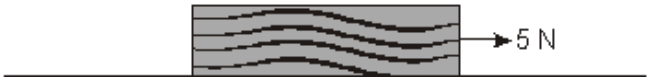
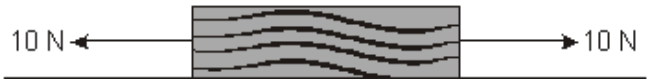
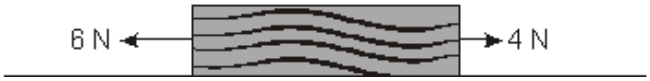
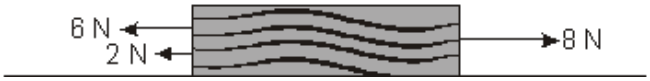
1 mark
maximum 6 marks

Q20. (a) Tasha puts a small block of wood on a smooth surface.



She puts different forces on the block.
The diagrams below show the size and direction of these forces.

Will each block move to the **left**, to the **right** or **stay still**?
Tick the correct box in each row.

forces on block	moves to the left ←	moves to the right →	stays still
(i) 	☐	☐	☐
(ii) 	☐	☐	☐
(iii) 	☐	☐	☐
(iv) 	☐	☐	☐

1 mark

1 mark

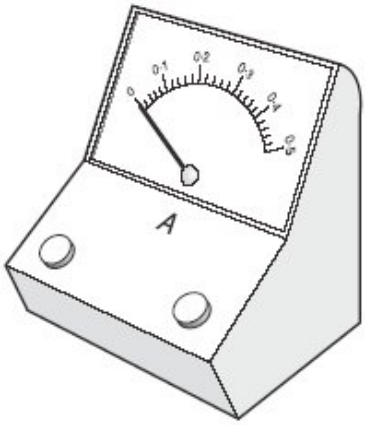
1 mark

1 mark

(b) (i) Which piece of equipment should Tasha use to measure the forces on the block?

Tick the correct box.

☐



☐

☐

☐

1 mark

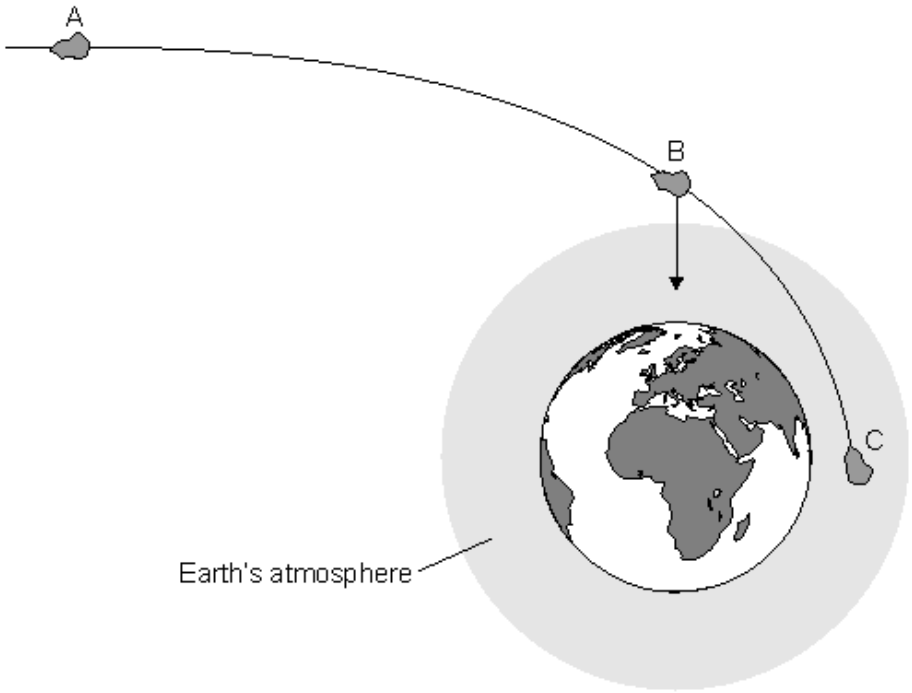
(ii) Give the name of the equipment used to measure force.

.....

1 mark

maximum 6 marks

Q21. The diagram below shows the path of a meteor as it gets closer to the Earth.
The meteor is shown in three positions: A, B and C.



not to scale

(a) The path of the meteor is affected by the Earth's gravity.
The arrow shows the direction of the force due to gravity acting on the meteor at B.

(i) **On the diagram** draw an arrow to show the direction of the force of gravity on the meteor at A.
Use a ruler.

1 mark

(ii) **On the diagram** draw an arrow to show the direction of the force of gravity on the meteor at C.
Use a ruler.

1 mark

(iii) How does the force of gravity on the meteor change as it travels from A to C?

.....

1 mark

(b) What happens to the speed of the meteor as it travels from A to B?

.....

1 mark

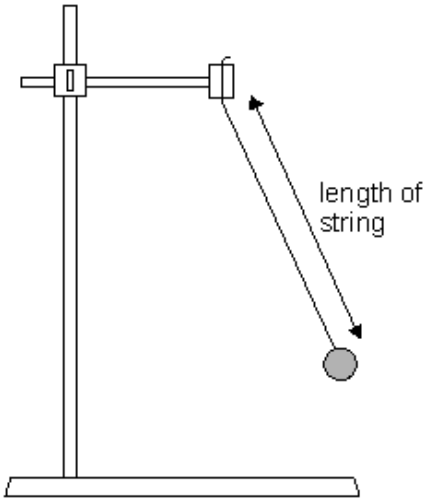
(c) When the meteor enters the Earth's atmosphere, three forces act on the meteor. Gravity and upthrust are two of these forces.

Give the name of the **other** force.

.....

1 mark
maximum 5 marks

Q22. Paula made a pendulum from a ball attached to a piece of string.



She counted the number of swings the ball made in 10 seconds.
She repeated the experiment with different lengths of string.

The table below shows Paula's results.

length of string (cm)	number of swings in 10 seconds
10	16
20	11
30	9
40	8
50	7

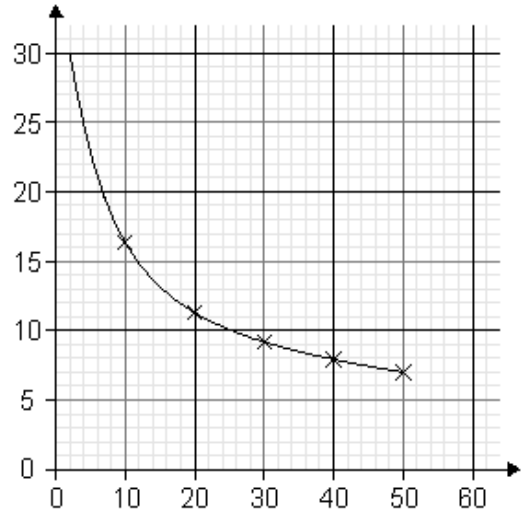
(a) What happens to the number of swings when the string gets longer?

.....

1 mark

(b) Paula drew a graph of her results.

(i) Write the labels on **both axes** of the graph below.
Use the table to help you.



2 marks

(ii) Paula made a pendulum from a piece of string that was 15 cm long.
How many times would this pendulum swing in 10 seconds?
Use the graph to help you.

.....

1 mark

(iii) Paula made a pendulum from a piece of string that was 60 cm long.
Estimate the number of swings the pendulum makes in 10 seconds.
Use the graph.
Tick the best answer.

18 ☐ 12 ☐ 6 ☐ 4 ☐

1 mark

(c) After some time the pendulum stops moving.
What force makes the pendulum stop moving?

.....

1 mark
maximum 6 marks