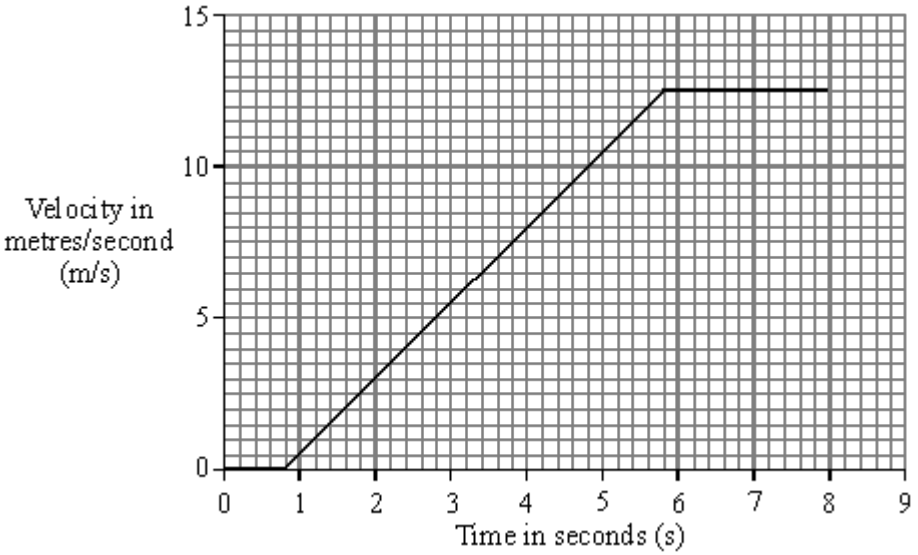
Name _____

Q1. A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



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

.....

(1)

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

.....

.....

Distance = ...metres

(3)

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

.....

.....

.....

Acceleration = ...

(4)

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

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

.....

(1)

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

.....

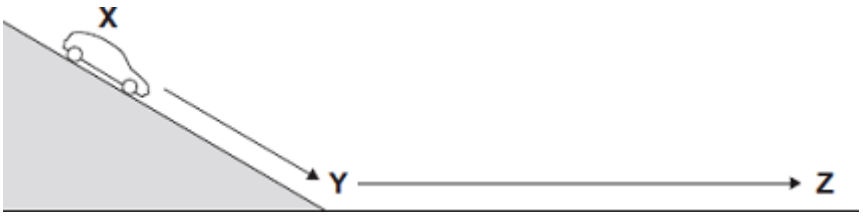
.....

Force = ... newtons

(2)

(Total 11 marks)

Q2.(a) The diagram shows a car at position **X**.



The handbrake is released and the car rolls down the slope to **Y**.
The car continues to roll along a horizontal surface before stopping at **Z**.
The brakes have **not** been used during this time.

(i) What type of energy does the car have at **X**?

.....

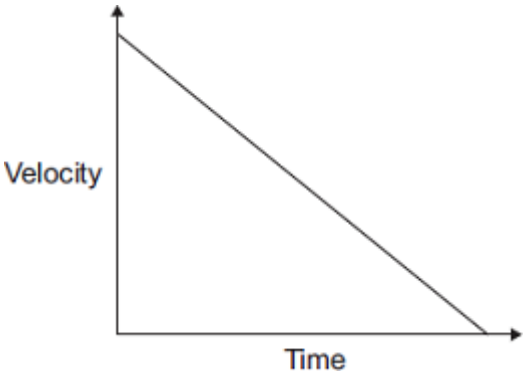
(1)

(ii) What type of energy does the car have at **Y**?

.....

(1)

(b) The graph shows how the velocity of the car changes with time between **Y** and **Z**.



(i) Which feature of the graph represents the negative acceleration between **Y** and **Z**?

.....

(1)

(ii) Which feature of the graph represents the distance travelled between **Y** and **Z**?

.....

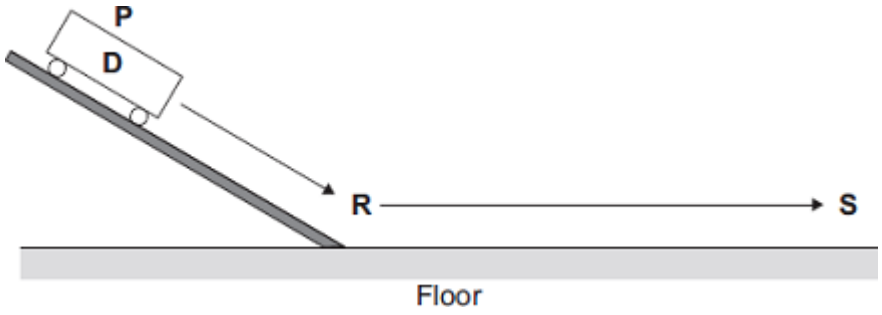
(1)

(iii) The car starts again at position **X** and rolls down the slope as before. This time the brakes are applied lightly at **Y** until the car stops.

Draw on the graph another straight line to show the motion of the car between **Y** and **Z**.

(2)

(c) Three students carry out an investigation. The students put trolley **D** at position **P** on a slope. They release the trolley. The trolley rolls down the slope and along the floor as shown in the diagram.



The students measure the distance from **R** at the bottom of the slope to **S** where the trolley stops. They also measure the time taken for the trolley to travel the distance **RS**. They repeat the investigation with another trolley, **E**.

Their results are shown in the table.

Trolley	Distance RS in centimetres	Time taken in seconds	Average velocity in centimetres per second
D	65	2.1	
E	80	2.6	

(i) Calculate the average velocity, in centimetres per second, between **R** and **S** for trolleys **D** and **E**. Write your answers in the table.

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

.....

.....

.....

(3)

(ii) Before the investigation, each student made a prediction.

- Student **1** predicted that the two trolleys would travel the same distance.
- Student **2** predicted that the average velocity of the two trolleys would be the same.
- Student **3** predicted that the negative acceleration of the two trolleys would be the same.

Is each prediction correct?

Justify your answers.

.....

.....

.....

.....

.....

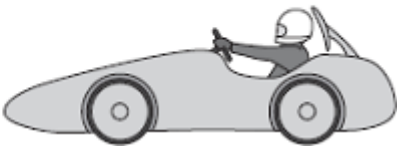
.....

(3)
(Total 12 marks)

Q3.(a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

First design **X**

Final design **Y**



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

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

Explain why.

.....

.....

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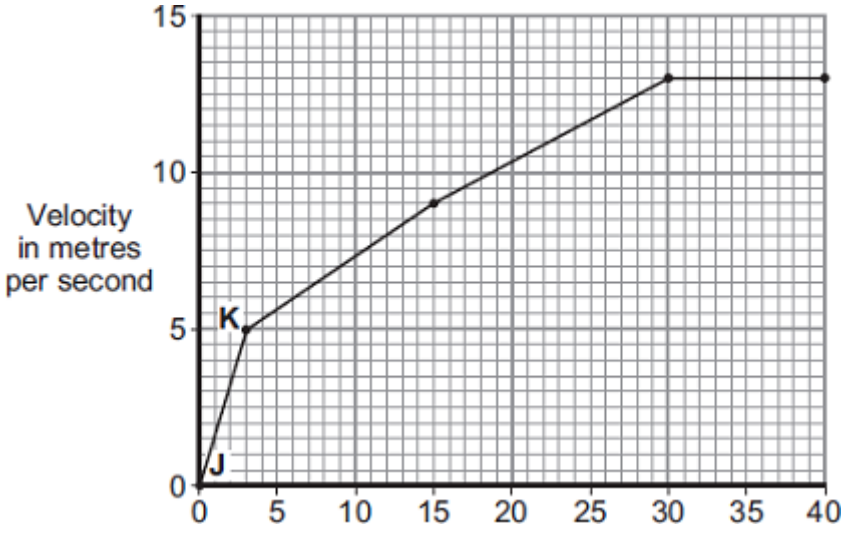
.....

.....

(3)

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

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



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

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

.....

.....

.....

Acceleration = ... m/s^2

(2)

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

.....

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.....

Distance = ... m

(2)

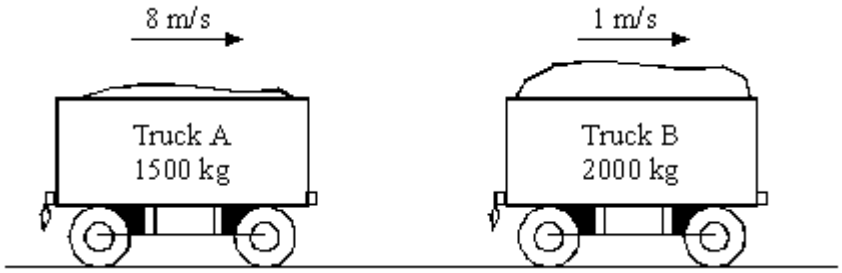
(iii) What causes most of the resistive forces acting on the go-kart?

.....

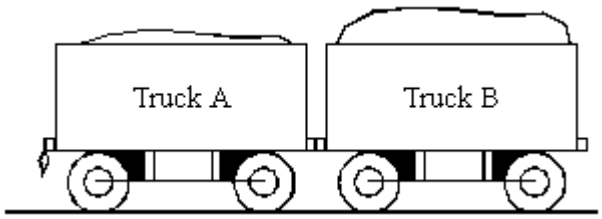
(1)

(Total 8 marks)

Q4. 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.

.....

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.....

.....

(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.

.....

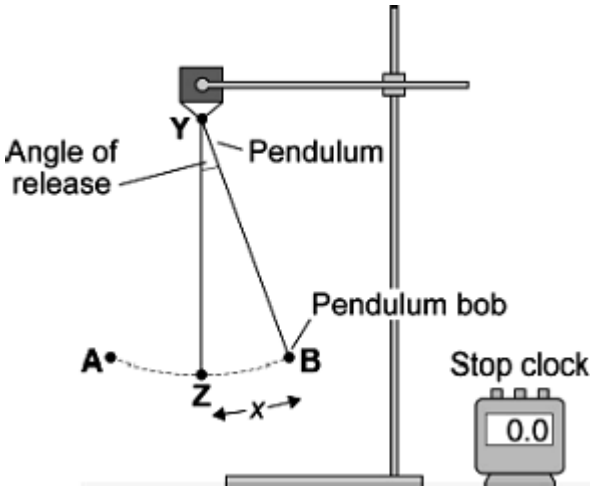
(iii) What would have been the effect on the change of total kinetic energy of the trucks if the collision had been more elastic?

.....

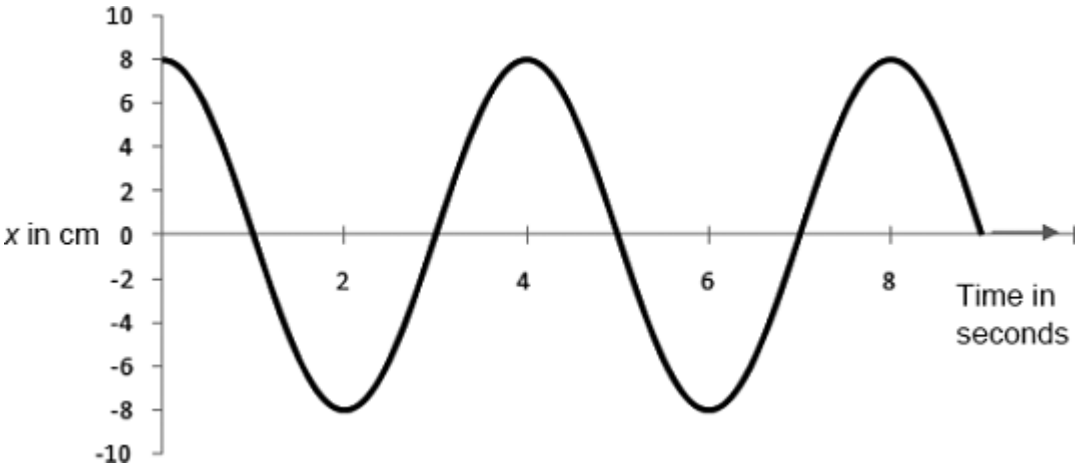
(3)

(Total 14 marks)

Q5.(a) A pendulum is a device that can be used for timing. Some clocks rely on the swing of a pendulum to keep time.
The pendulum shown in the diagram below is suspended from point **Y** and swings from **A** to **B**, through the centre point **Z**.



The displacement *x* of the pendulum bob was plotted against time as shown in the graph below.



By analysing the evidence in the graph, find the amplitude of the oscillation of the pendulum and the time period of the pendulum.

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.....

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(2)

(b) A student carried out an investigation to find out how the time period of the pendulum depends on the length of the pendulum.

During the investigation she kept the mass of the pendulum bob and the angle of release constant. Her data is recorded in **Table 1**.

Table 1

	Length of pendulum in metres	**Time for 10 swings in seconds**	**Time period in seconds**
1	0.20	9.2	0.92
2	0.40	12.8	1.2
3	0.60	15.0	1.50
4	0.80	18.0	1.80
5	1.00	20.0	2.00

(i) Explain why the student timed ten swings, rather than just timing one swing, for each length of pendulum.

.....

.....

.....

.....

(2)

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

Describe the steps that the student would take to obtain the data shown in **Table 1**.

In your description, comment on the number of decimal places and significant figures the student has used in each column.

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(6)

(iii) The student also carried out two more pendulum investigations.
During the second investigation she kept the length of the pendulum and the angle of release constant. The data for this investigation is recorded in **Table 2**.

Table 2

	Mass of pendulum bob in grams	**Time for 10 swings in seconds**	**Time period in seconds**
1	2.5	20.0	2.00
2	5.0	20.3	2.03
3	7.5	20.1	2.01
4	10.0	20.0	2.00
5	12.5	20.2	2.02

During the third investigation she kept the length of the pendulum and the mass of the pendulum bob constant. The data for this investigation is recorded in **Table 3**.

Table 3

	Angle of release in degrees	**Time for 10 swings in seconds**	**Time period in seconds**
1	2	20.4	2.04
2	4	20.2	2.02
3	6	20.0	2.00
4	8	20.3	2.03
5	10	20.1	2.01

What conclusions can be made from the data recorded in **Table 1**, **Table 2** and **Table 3**?
Your answer should include a comment on the quality of the evidence.

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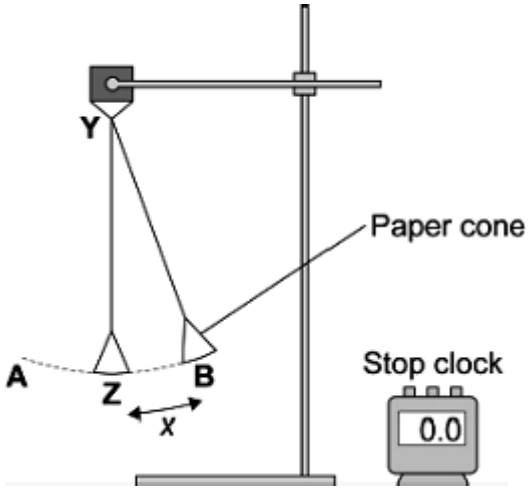
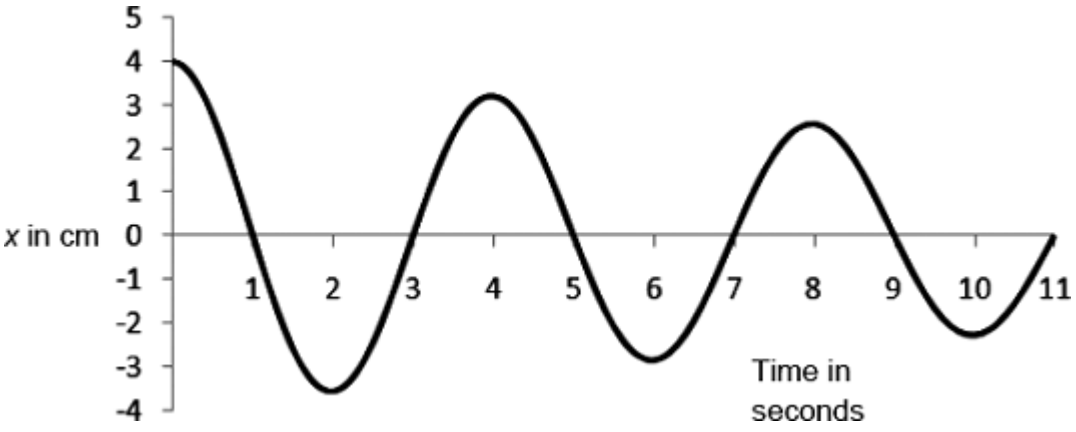
(3)

(c) The student replaced the pendulum bob with a light paper cone as shown in the diagram.



She plotted the displacement *x* of the pendulum bob against time as shown in the graph below.



The student concluded that the frequency of this pendulum decreased with time.
Does the graph support her conclusion?

Explain the reason for your answer.

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.....

(2)
(Total 15 marks)

Q6. Forces have different effects.

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

slowing	**stretching**	**turning**

The moment of a force is the ..... effect of the force.

(1)

(ii) What is meant by the centre of mass of an object?

.....

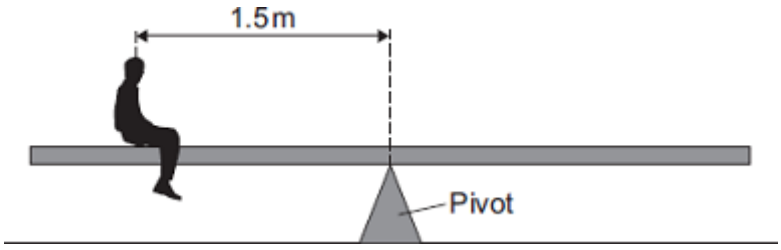
.....

(1)

(b) Some children build a see-saw using a plank of wood and a pivot.
The centre of mass of the plank is above the pivot.

Figure 1 shows a boy sitting on the see-saw. His weight is 400 N.

Figure 1



Calculate the anticlockwise moment of the boy in Nm.

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

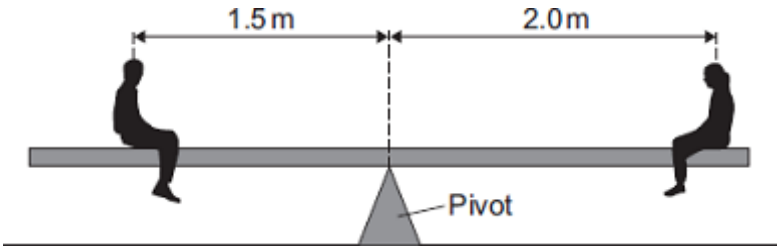
.....

Anticlockwise moment = ... Nm

(2)

(c) **Figure 2** shows a girl sitting at the opposite end of the see-saw. Her weight is 300 N.

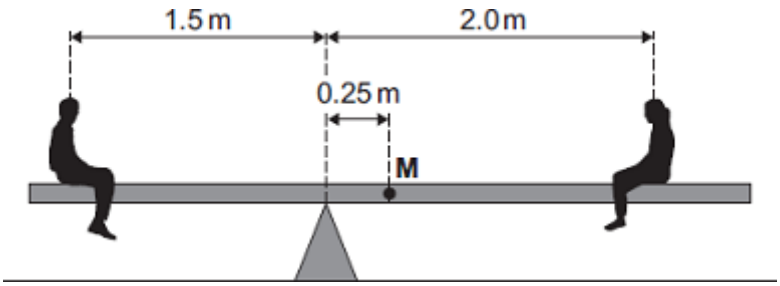
Figure 2



The see-saw is now balanced.

The children move the plank. Its centre of mass, **M**, is now 0.25 m from the pivot as shown in **Figure 3**.

Figure 3



The boy and girl sit on the see-saw as shown in **Figure 3**.

(i) Describe **and** explain the rotation of the see-saw.

.....

.....

.....

.....

.....

(3)

(ii) The boy gets off the see-saw and a bigger boy gets on it in the same place. The girl stays in the position shown in **Figure 3**. The plank is balanced. The weight of the plank is 270 N.

Calculate the weight of the bigger boy.

.....

.....

.....

Weight of the bigger boy = ... N

(3)

(Total 10 marks)

Q7. The hammer throw is an athletic event. The athlete throws a heavy metal ball attached by a wire to a handle.

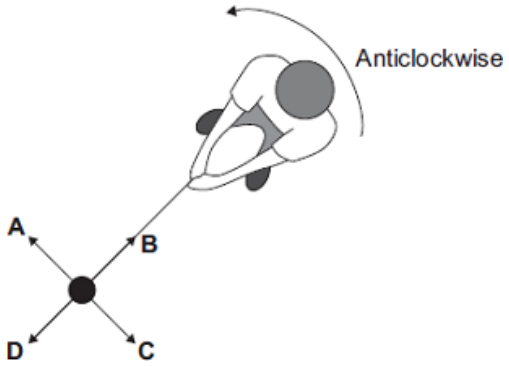
(a) The hammer thrower swings the hammer round in a circle before letting go. He swings the hammer slowly at first and then faster. Complete the following sentence by drawing a ring around the correct line in the box.

As the speed of the swing increases, the centripetal force on the hammer

decreases.
does not change.
increases.

(1)

(b) The diagram shows an overhead view of a hammer thrower swinging the hammer anticlockwise in a circle.



(i) In which direction, **A**, **B**, **C** or **D**, does the centripetal force act on the hammer? _____ **(1)**

(ii) Complete the following sentence by drawing a ring around the correct answer.

The centripetal force is provided by the

air resistance.
gravitational force.
tension in the wire.

(1)

(iii) At the instant shown in the diagram above, the athlete lets go of the handle.

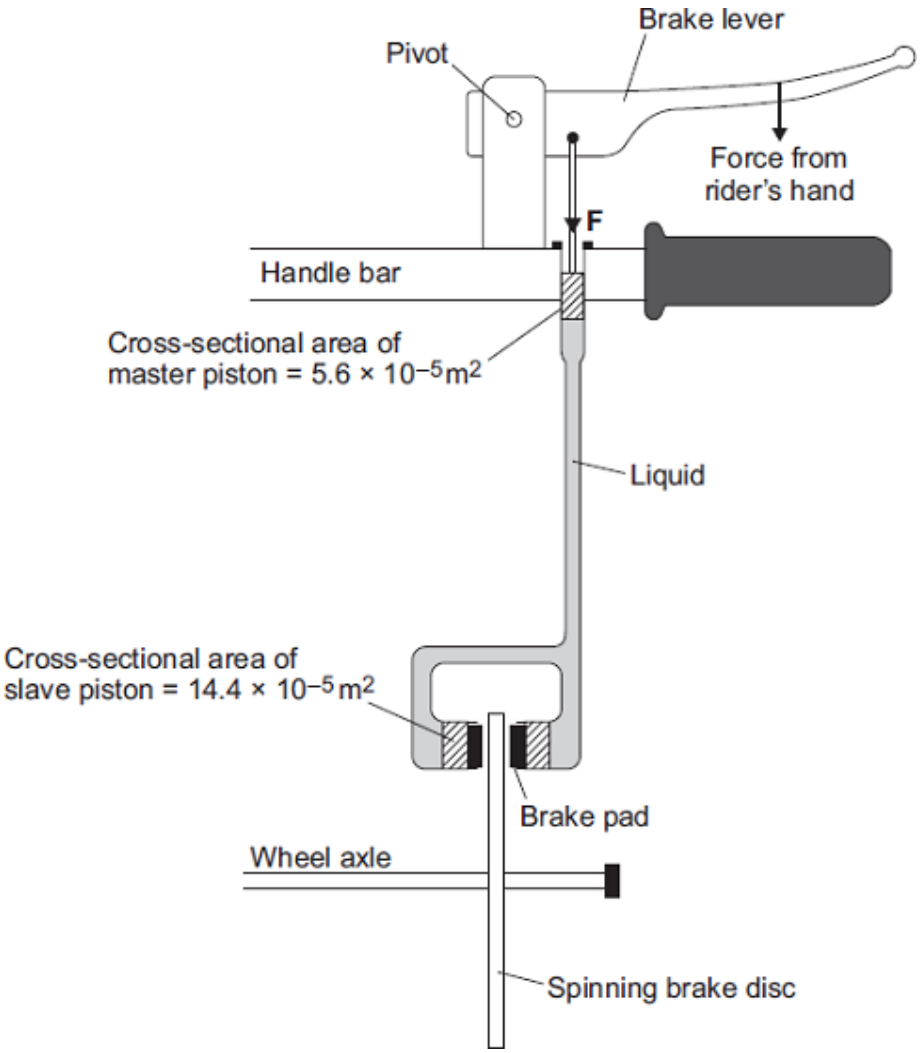
In which direction, **A**, **B**, **C** or **D**, does the hammer move? ☐

(1)

(Total 4 marks)

Q8. Mountain bike riders use brakes to slow down.

Some mountain bikes have hydraulic brakes.



(a) What property of a liquid enables a hydraulic brake system to work?

.....

(1)

(b) When the rider's hand pulls on the brake lever, the master piston applies a pressure of 1.5×10^6 pascals to the liquid.

Using information from the diagram, calculate the force **F** exerted on the liquid by the master piston.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Force **F** = ... N

(2)

(c) The pressure in the liquid applies a force to move each slave piston.

How does the size of this force compare to the force **F** applied by the master piston?

.....

.....

Give a reason for your answer.

.....

.....

(2)

(Total 5 marks)