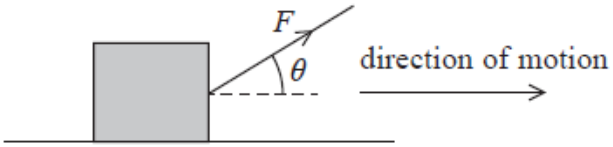
Questions

Q1.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A rope is used to apply a force *F* to a box as shown. The box is pulled a distance *d* along a horizontal surface.



Which of the following could be used to determine the work done on the box?

☒ **A** $Fd \sin \theta$

☒ **B** $\frac{Fd}{\sin \theta}$

☒ **C** $Fd \cos \theta$

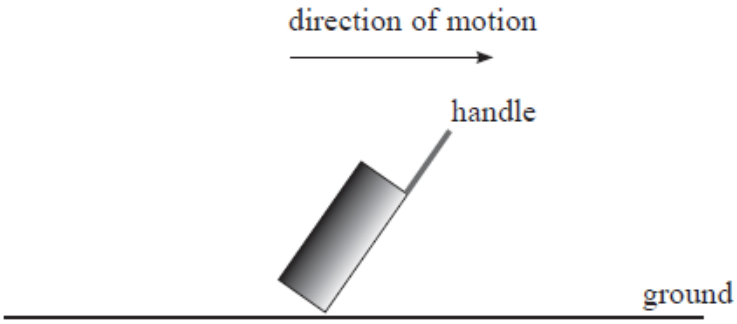
☒ **D** $\frac{Fd}{\cos \theta}$

(Total for question = 1 mark)

Q2.

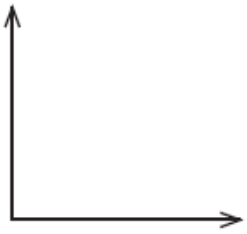
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A suitcase is being dragged along the ground by the handle in the direction shown.

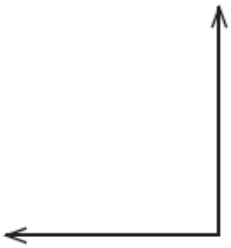


Which of the following shows the direction of the horizontal and vertical components of force acting on the ground due to the suitcase?

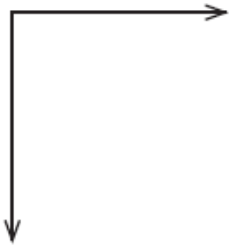
☒ **A**



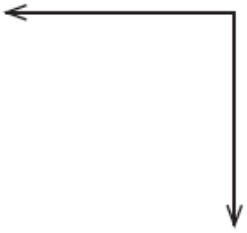
☒ **B**



☒ **C**



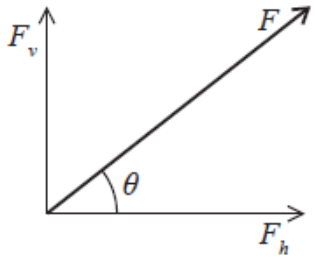
☒ **D**



(Total for question = 1 mark)

Q3.

A force F is resolved into two components, F_h and F_v, at right angles to one another.



Which statement is **not** true?

☒ **A** Decreasing θ increases the magnitude of F_h.

☒ **B** Increasing θ increases the magnitude of F_v.

☒ **C** F_h and F_v have magnitudes that when added together give a total equal to the magnitude of F.

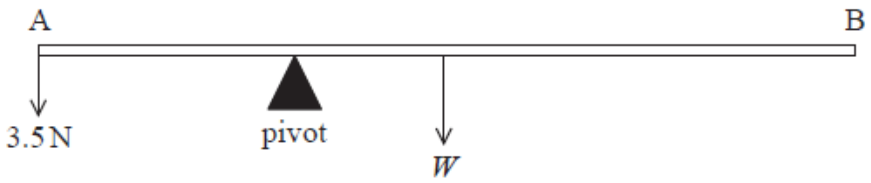
☒ **D** F_h and F_v have magnitudes that when added together give a total greater than the magnitude of F.

(Total for question = 1 mark)

Q4.

A uniform rigid rod AB of length 1.50 m has a weight W of 6.5 N. A force of 3.5 N applied at A balances the rod on a pivot as shown.

Diagram not to scale



Calculate the distance of the pivot from A when the rod is in equilibrium.

(2)

.....

.....

.....

.....

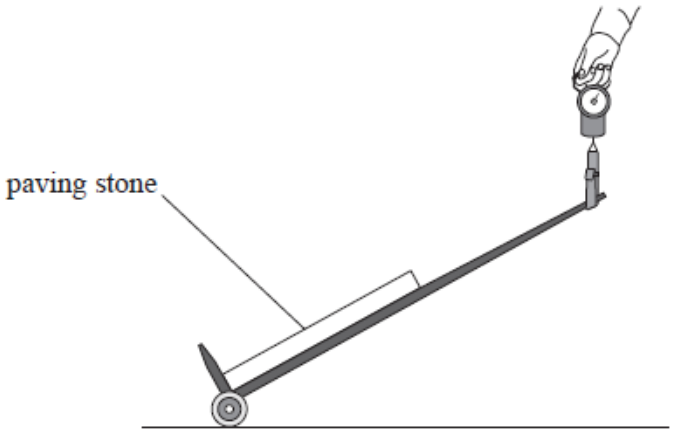
.....

Distance of pivot from A = ...

(Total for question = 2 marks)

Q5.

A gardener used a trolley to move a paving stone.



A force meter was attached to the handle of the trolley.

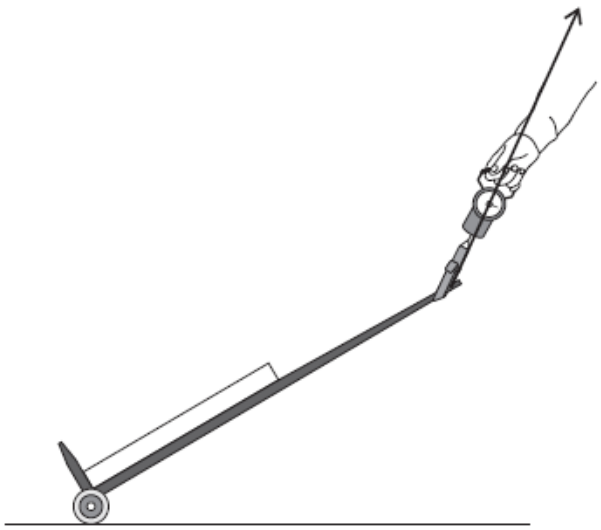
The gardener recorded the following measurements when the trolley was at rest in the position shown in the diagram.

mass of trolley and paving stone = 18.5 kg

length of trolley = 97 cm

force on handle = 50 N

The gardener then pulled the trolley and measured the applied force while the trolley was moving.



The direction of the applied force is 25° to the vertical, as shown by the arrow.

(i) Calculate the magnitude of the applied force.

Assume the magnitude of the vertical component of the force remains at 50 N.

(2)

.....

.....

.....

.....

Magnitude of applied force = ...

(ii) The gardener continues to walk and pulls the trolley a distance of 15 m in a time of 4.2 s.

Calculate the power developed while pulling the trolley.

(3)

.....

.....

.....

.....

Power = ...

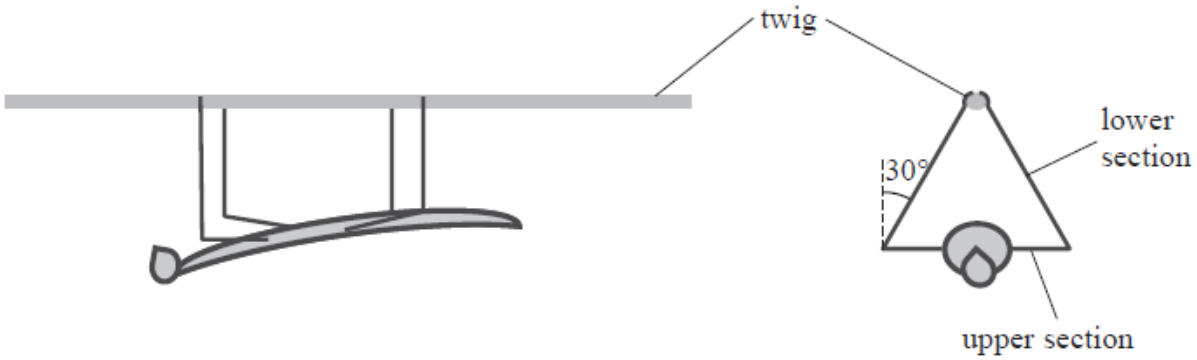
(Total for question = 5 marks)

Q6.

The photograph shows a praying mantis hanging from a thin twig. Four of the praying mantis's six legs are in contact with the twig. The tension in the legs balances the weight to keep the praying mantis stationary.

© Robert Clamp

(a) The diagrams show a simplified model of the situation. For each leg in contact with the twig, the upper section is horizontal and the lower section is at an angle of 30° to the vertical.



(i) Calculate the tension in the lower section of each leg in contact with the twig assuming that these tensions are all equal.

mass of praying mantis = 5.4×10^{-4} kg

(4)

.....

.....

.....

.....

.....

.....

Tension = ...

(ii) A student suggests that the tension in each leg in contact with the twig is 25% of the weight of the praying mantis. State why this is **not** correct.

(1)

.....

.....

.....

(b) The praying mantis moves around the twig so that it is now standing upright and on top of the twig.

State the difference between the stress in the legs when the praying mantis is beneath the twig and when it is on top of the twig.

(1)

.....

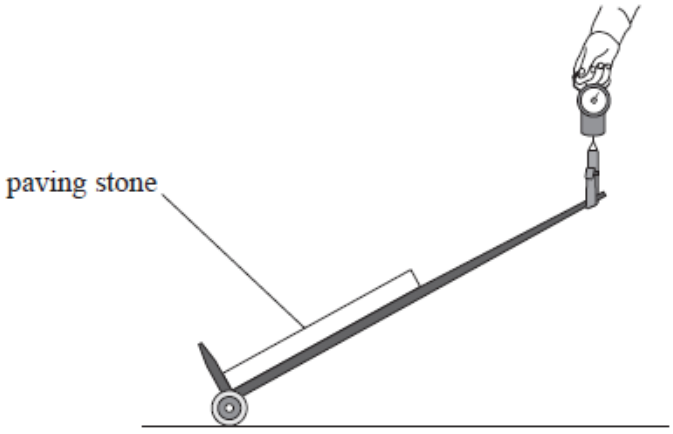
.....

.....

(Total for question = 6 marks)

Q7.

A gardener used a trolley to move a paving stone.



A force meter was attached to the handle of the trolley.

The gardener recorded the following measurements when the trolley was at rest in the position shown in the diagram.

mass of trolley and paving stone = 18.5 kg

length of trolley = 97 cm

force on handle = 50 N

Determine the distance of the centre of gravity of the loaded trolley from the wheels.

(3)

.....

.....

.....

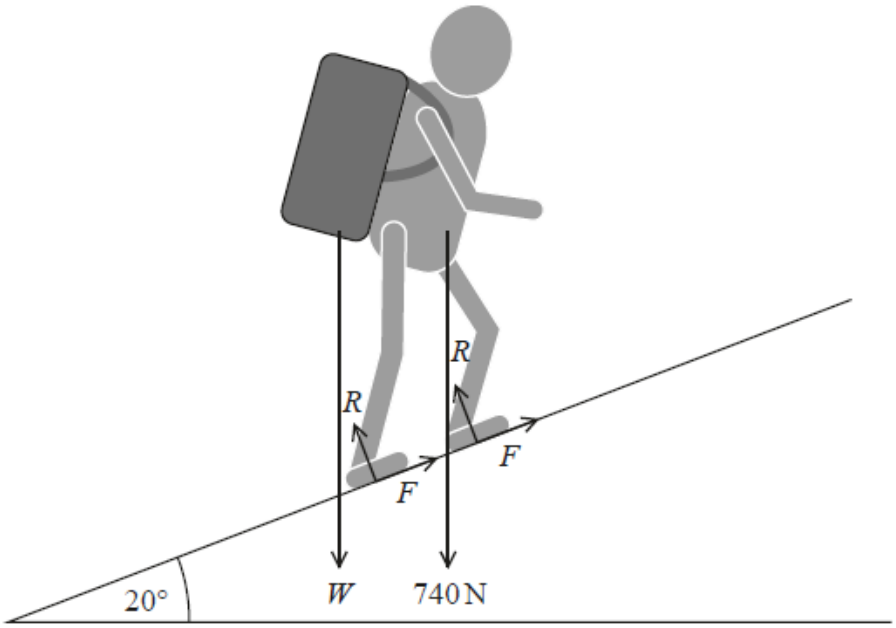
.....

Distance = ...

(Total for question = 3 marks)

Q8.

A hiker of weight 740N walks up a hill carrying a large bag of weight *W*. The hiker stops for a moment in the position shown.



The normal force *R* of the ground on the hiker is the same at each foot. The frictional force between each foot and the ground is *F*. The hill is at an incline of 20° to the horizontal.

The hiker repacks his bag, placing the heavier items at the bottom of the bag.

Explain why this may cause *R* on the front foot to decrease.

(2)

.....

.....

.....

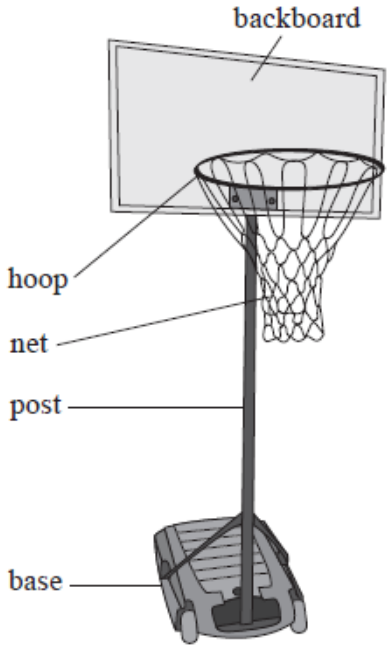
.....

.....

(Total for question = 2 marks)

Q9.

A portable basketball set has a base and a post arrangement. The post arrangement consists of a post, backboard, hoop and net. The base can be filled with water to increase stability.



(a) The base has a capacity of 85.0 litres.

Show that the maximum weight of the base is about 870N.

mass of 1.00 litre of water = 1.00 kg
mass of base when empty = 3.50 kg

(2)

.....

.....

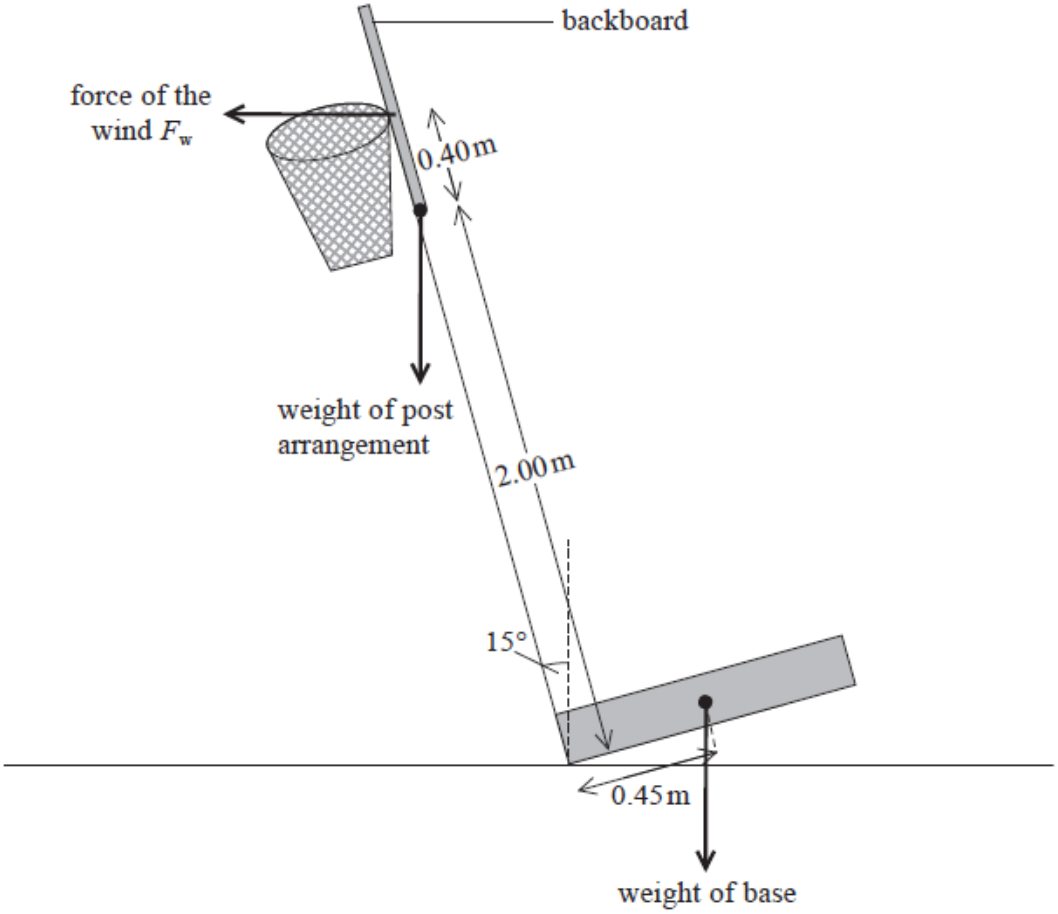
.....

.....

.....

.....

(b) Due to the large area of the backboard, the basketball set may topple over when the wind blows.



Calculate the minimum force of the wind F_w that will cause the basketball set to be blown over when it is at the angle shown. Ignore the effect of the wind on the base.

weight of post arrangement = 27.0 N

(5)

.....

.....

.....

.....

.....

.....

.....

.....

Minimum force of the wind F_w = ...

(c) The base is filled with sand instead of water. The density of sand is greater than the density of water.

State and justify what would happen to the value of F_w calculated in part (b).

(3)

.....

.....

.....

.....

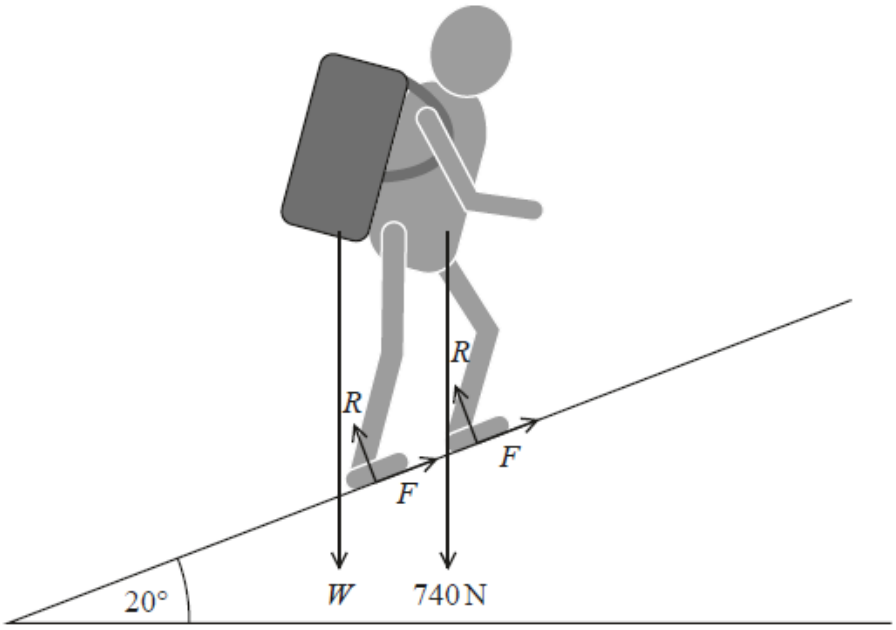
.....

.....

(Total for question = 10 marks)

Q10.

A hiker of weight 740N walks up a hill carrying a large bag of weight *W*. The hiker stops for a moment in the position shown.



The normal force *R* of the ground on the hiker is the same at each foot. The frictional force between each foot and the ground is *F*. The hill is at an incline of 20° to the horizontal.

An expression for the components of force perpendicular to the ground acting on the hiker is

$740\cos 20 + W\cos 20 - 2R = 0$

(i) Explain why this expression is correct.

(2)

.....

.....

.....

.....

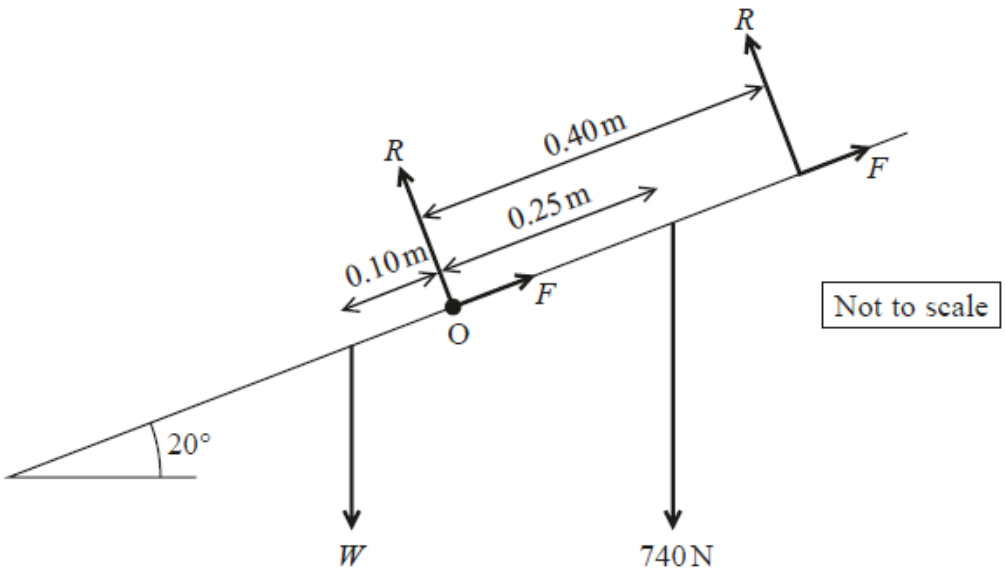
.....

.....

.....

.....

(ii) The diagram shows the lines of action of the forces acting on the hiker and backpack. Position O represents the middle of the back foot of the hiker.



Determine W. You should take moments about O.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

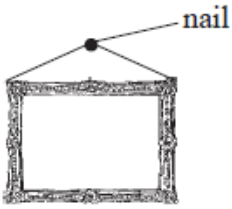
W = ...

(Total for question = 8 marks)

Q11.

A thin wire of negligible mass is used to hang a picture on a wall. The wire is hung over a nail and can be attached to the picture using arrangement 1 or arrangement 2, as shown.

arrangement 1



arrangement 2

It was observed that if the wire was not hung with its midpoint over the nail, as in Diagram 1, the picture moved and then remained in the position shown in Diagram 2.

Diagram 1

Diagram 2

Use the idea of moments to explain why.

(3)

.....

.....

.....

.....

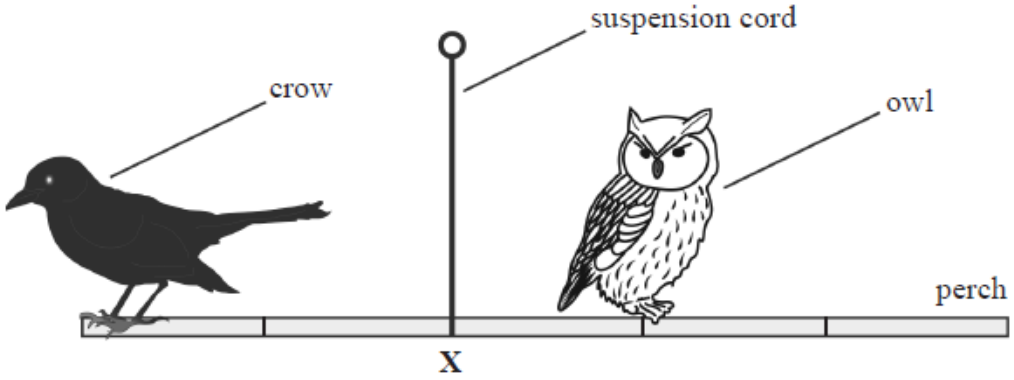
.....

.....

(Total for question = 3 marks)

Q12.

In a 'balancing birds' puzzle, model owls and crows are each placed in one of six equally spaced positions marked on a perch. The perch has negligible mass, and is suspended from another of the six marked positions. With the birds placed, and the perch suspended, as shown, the puzzle is in equilibrium.



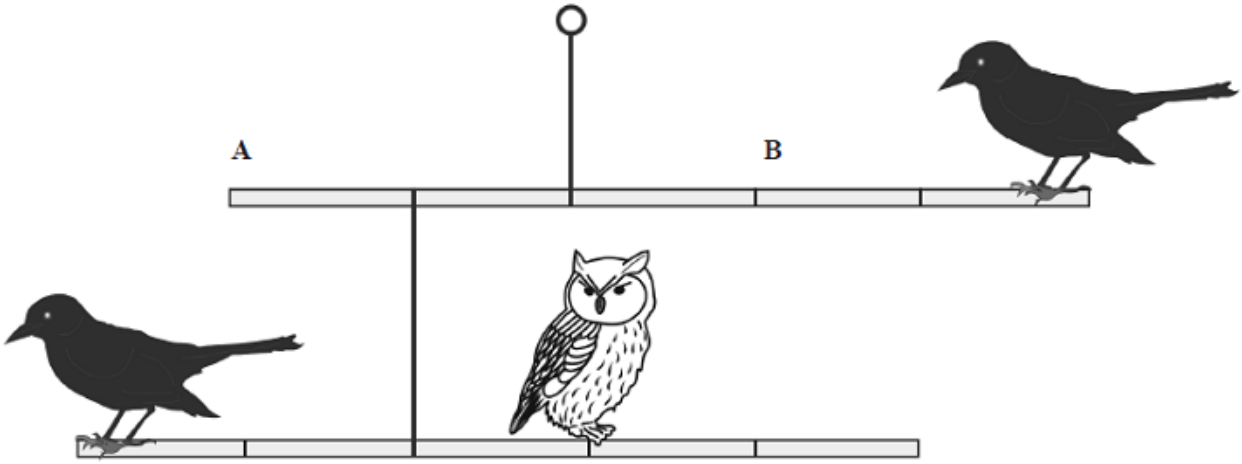
(i) The owl has a mass 2*M* and the crow has a mass *M*. Show that the perch will balance when suspended as shown from position X.

(1)

.....

.....

(ii) The perch is then attached to a second perch and suspended as shown. Two more birds, not shown, are placed at A and B, and the whole arrangement is in equilibrium. Each crow has the same mass *M*. The mass of an owl is 2*M*.



Explain, with the aid of a calculation, which type of bird sits at A and which type of bird sits at B to ensure the whole arrangement is in equilibrium.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Mark Scheme

Q1.