2 A 50 cm rule is balanced at its mid-point. A force of 8.0 N acts at a distance of 10 cm from one end of the rule.

Fig. 2.1 shows the arrangement.

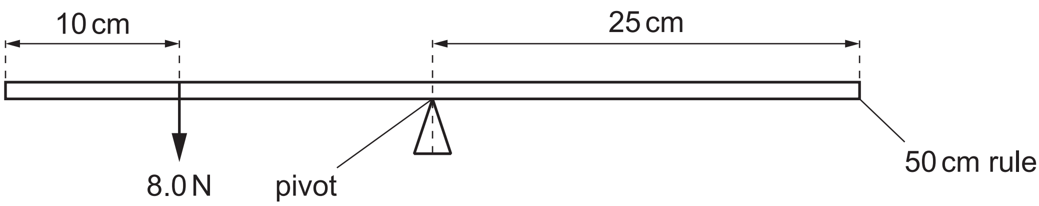

Fig. 2.1

(a) Calculate the moment of the 8.0 N force about the pivot. Give the unit.

moment = ...

unit = ...
[5]

(b) Another force acts at a point 10 cm from the pivot. It makes the rule balance.

On Fig. 2.1, draw an arrow to show the position and direction of this force. [2]

[Total: 7]

2 **(a)** State the **two** conditions which must be true for an object to be in equilibrium.

condition 1 ....

condition 2 ....
[2]

(b) Fig. 2.1 shows a uniform metre rule PQ in equilibrium.

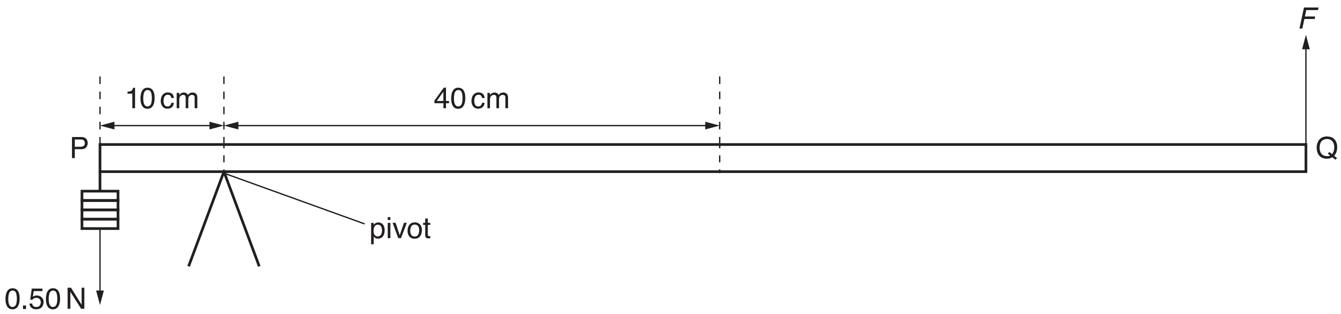

Fig. 2.1

The distance PQ is 100 cm. The mass of the metre rule is 0.12 kg and its weight is *W*.

(i) On Fig 2.1, draw and label:

1. an arrow to show the force *W* acting on PQ at the centre of mass

2. an arrow to show the force *R* acting on PQ at the pivot.

[2]

(ii) By taking moments about the pivot, calculate *F*.

F = ... [4]

(iii) Calculate *R*.

R = ... [2]

[Total: 10]

4 (a) Fig. 4.1 shows a top view of a tourist vehicle in a game park and two elephants pushing against the vehicle. The two forces indicated are at right angles to each other.

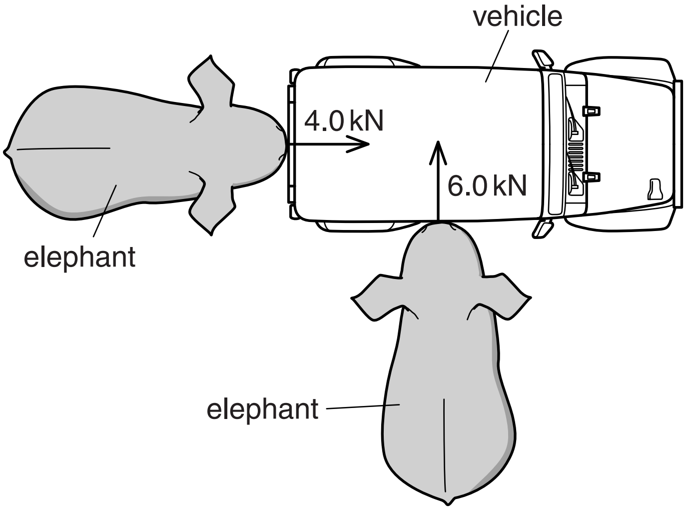

Fig. 4.1

In the space below, draw a scale vector diagram to determine the magnitude of the resultant force. Label the two forces applied and the resultant, and clearly state the scale you use.

magnitude of resultant force = ... [3]

(b) Fig. 4.2 shows another elephant pushing horizontally against a vehicle with a force of 11 kN at a distance 1.8 m above the ground. Point M is the centre of mass of the vehicle.

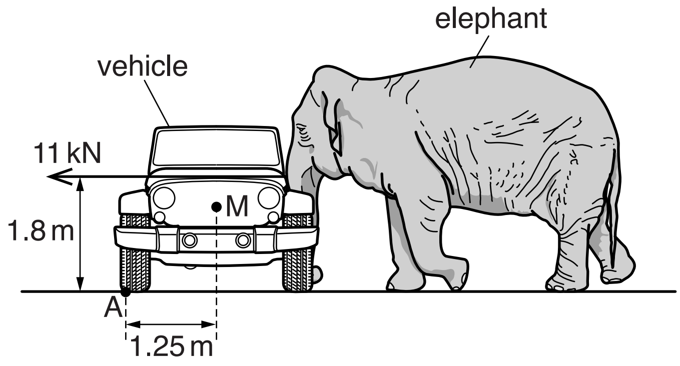

Fig. 4.2

(i) Calculate the moment about point A of the force exerted by the elephant.

moment = ...[2]

(ii) The mass of the vehicle is 1900 kg, and it does not slide when pushed by the elephant.

Determine whether the elephant tips the vehicle over. Show your working.

calculation

conclusion ....[2]

[Total: 7]

2 Fig. 2.1 shows a mobile bird sculpture that has been created by an artist.

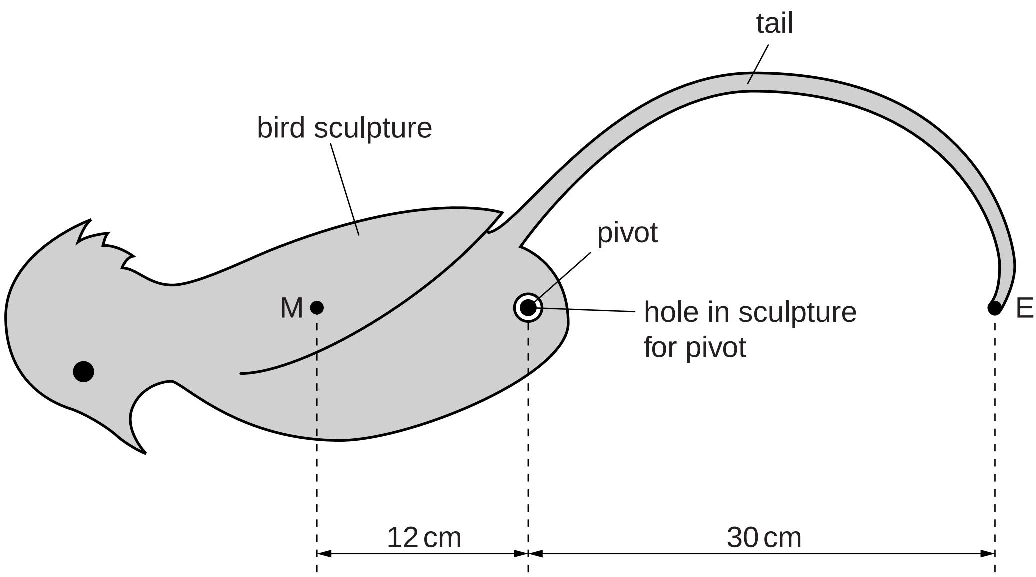

Fig. 2.1

M is the centre of mass of the bird sculpture, including its tail (but not including the counter-weight that will be added later). The mass of the bird and tail is 1.5 kg.

The bird sculpture is placed on a pivot.

The artist adds the counter-weight at the end E of the tail so that the bird remains stationary in the position shown.

(a) Calculate the mass of the counter-weight.

mass = ... [2]

(b) The centre of mass of the sculpture with counter-weight is at the pivot.

Calculate the upward force acting at the pivot.

force = ... [1]

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(c) The sculpture is rotated clockwise to the position shown in Fig. 2.2. It is held still, then carefully released.

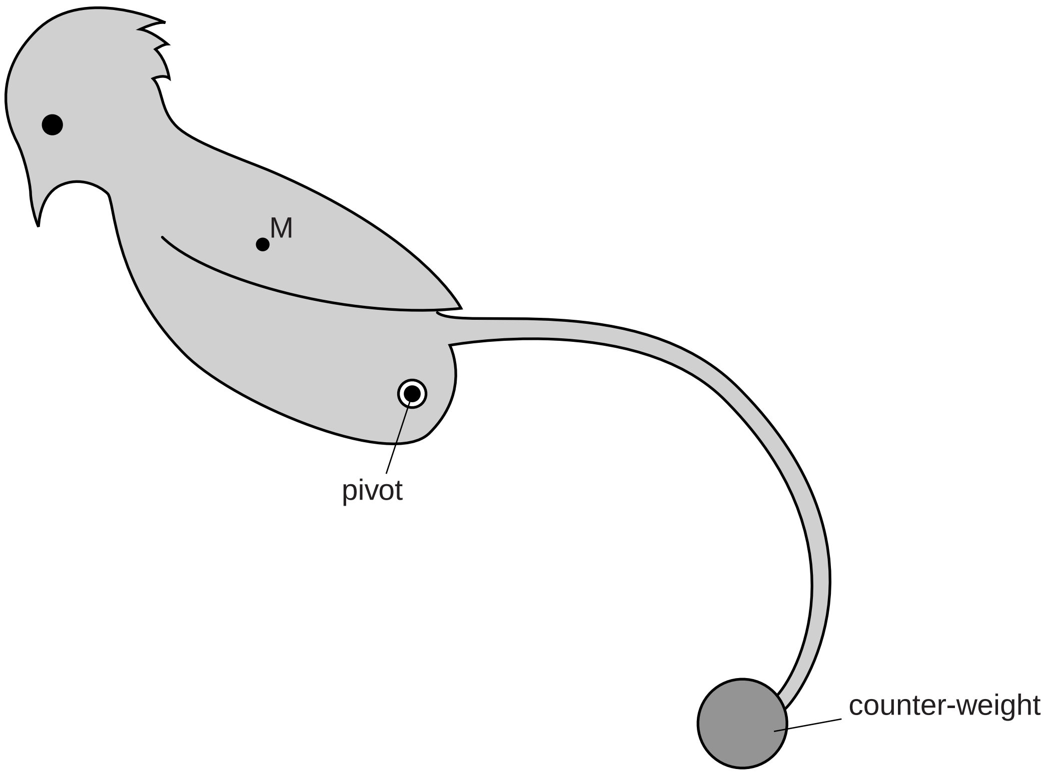

Fig. 2.2

(i) State whether the sculpture will stay in that position, rotate further clockwise or rotate back anticlockwise.

....

....

(ii) Explain your answer to **(i)**.

....

....

....

....
[3]

[Total: 6]

3 **(a)** Complete the following statement.

An object is in equilibrium when both the .... and the

.... on the object are zero. [2]

(b) Fig. 3.1 shows a ladder AB. End A of the ladder rests against a vertical wall. End B rests on rough ground.

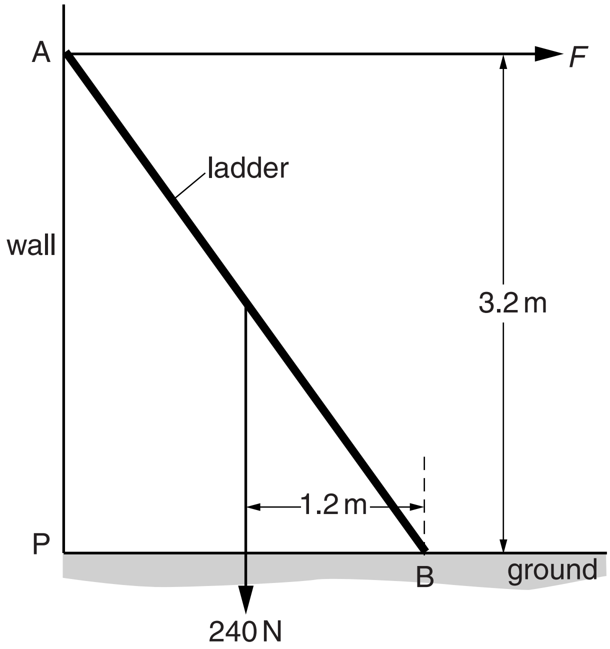

Fig. 3.1

Fig. 3.1 shows two of the forces acting on the ladder. The only force on the ladder at A is *F*, which acts at right-angles to the wall. The weight of the ladder is 240 N acting at the centre of mass of the ladder.

(i) **1.** Calculate the moment of the weight of the ladder about point B.

moment = ... [1]

2. Write an expression, in terms of *F*, for the moment of *F* about point B.

moment = ... [1]

(ii) Use your answers from **(i)** to calculate *F*.

F = ... [2]

(iii) Explain why there must be an upwards force acting on the ladder at B.

....

.... [1]

[Total: 7]

1 **(a)** State the two conditions necessary for a system of forces acting on a body to be in equilibrium.

1. ....

....

2. ....

.... [2]

(b) Fig. 1.1 shows a loaded wheelbarrow held in equilibrium by a gardener. The wheel of the wheelbarrow is in contact with the ground at point C.

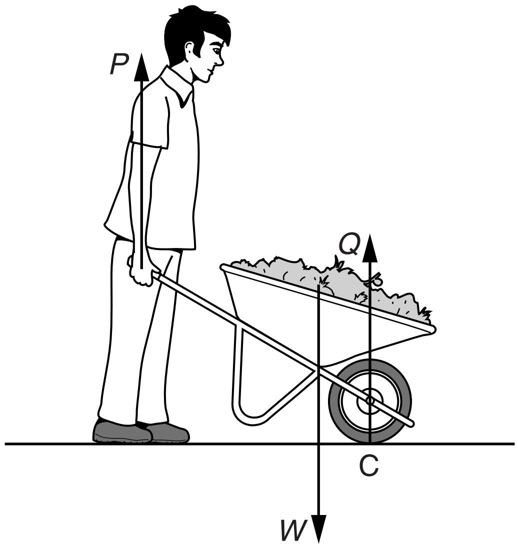

Fig. 1.1

In Fig. 1.1, there are three vertical forces acting on the wheelbarrow.

P is the upward force applied by the gardener.
Q is the upward force of the ground on the wheel at point C.
W is the weight of the wheelbarrow and its contents.

Explain why the force *P* is less than the force *W*

(i) by considering the forces *P, Q* and *W*,

....

.... [2]

(ii) by considering the moments of the forces *P* and *W* about point C.

....

.... [2]

(c) Fig. 1.2 shows a kitchen cupboard resting on a support and attached to a wall by a screw.

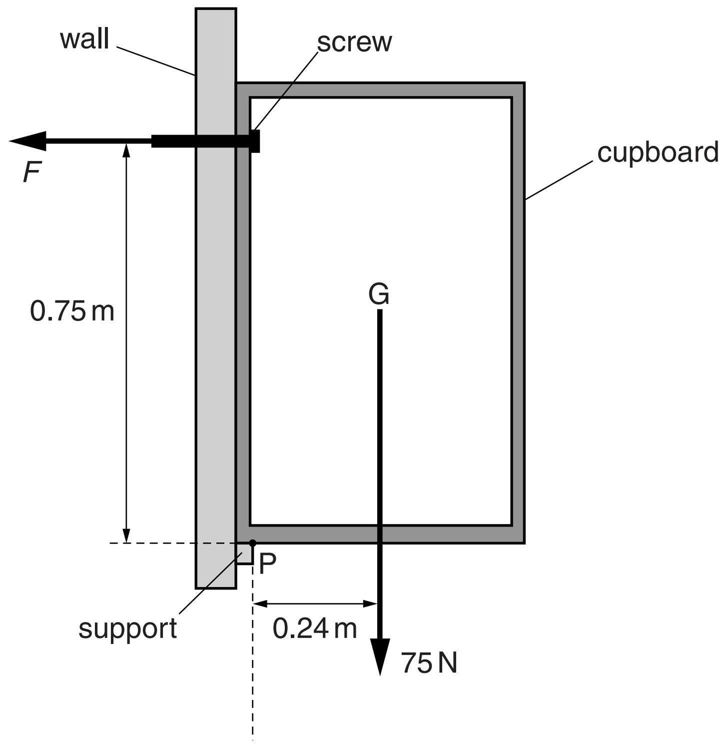

Fig. 1.2

The weight of the cupboard and its contents is 75 N. G is the position of the centre of mass of the cupboard.

The clockwise and anticlockwise moments about point P are equal.

Calculate the force *F* exerted by the screw.

F = ... [3]

[Total: 9]

3 **(a)** Complete the following statement:

The moment of a force about a point is ....

multiplied by ....[1]

(b) Fig. 3.1 shows a uniform iron bar B of weight 30 N and length 1.40 m. The bar is being used to lift one edge of a concrete slab S. A stone, placed 0.20 m from one end of B, acts as a pivot. A force of 40 N pushing down at the other end of B is just enough to lift the slab and hold it as shown.

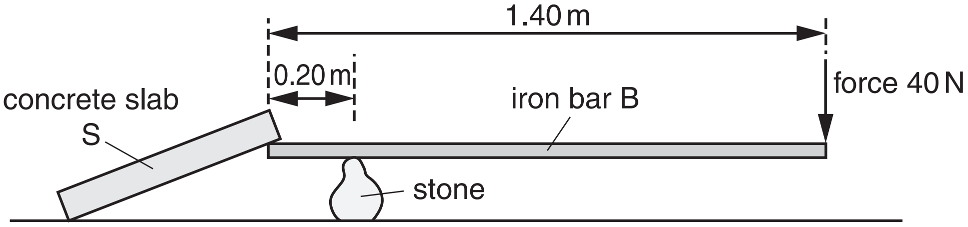

Fig. 3.1

(i) On Fig. 3.1, draw an arrow to show the weight of bar B acting from its centre of mass. [1]

(ii) State the distance *d* of the centre of mass of bar B from the pivot.

d = ...[1]

(iii) Calculate the total clockwise moment, about the pivot, of the forces acting on bar B.

total clockwise moment = ...[3]

(iv) Calculate the downward force which the slab S exerts on the end of bar B.

force = ...[2]

(v) Suggest a change to the arrangement in Fig. 3.1 that would reduce the force required to lift the slab.

....

....[1]

[Total: 9]

3 **(a)** A uniform metre rule is pivoted at its centre, which is also the position of its centre of mass.

Three loads, 2.0 N, *F* and 3.0 N are positioned on the rule at the 20 cm, 30 cm and 90 cm marks respectively, as shown in Fig. 3.1.

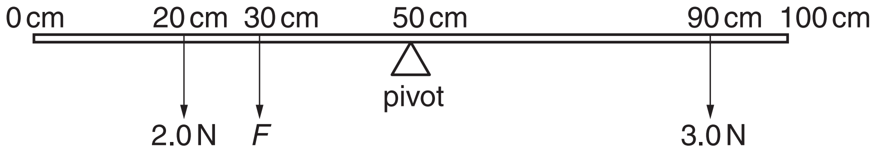

Fig. 3.1

(i) Calculate the moment of the 3.0 N load about the pivot.

moment = ... [1]

(ii) Calculate the moment of the 2.0 N load about the pivot.

moment = ... [1]

(iii) The force *F* maintains the metre rule in equilibrium on the pivot.

Calculate the value of *F*.

F = ... [3]

(b) The weight of the metre rule is 1.2 N and can be considered to act at the 50 cm mark.

All the weights in **(a)** are removed. The pivot is positioned under the 30 cm mark and the 2.0 N load is placed on the rule as shown in Fig. 3.2.

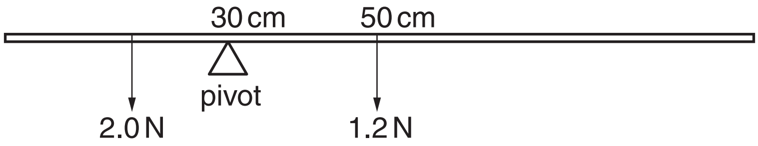

Fig. 3.2

The position of the 2.0 N load is adjusted until the metre rule is again in equilibrium.

Determine the position of the 2.0 N load.

2.0 N load is at the .... cm mark [3]

[Total: 8]