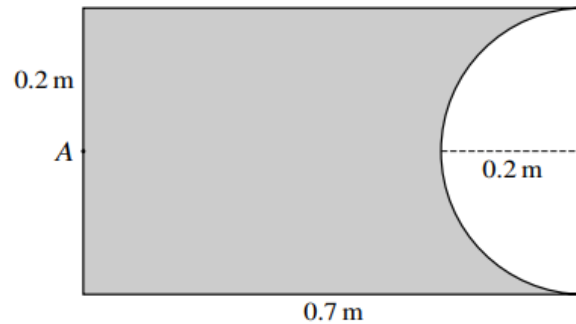


Equilibrium of a Rigid Body 1

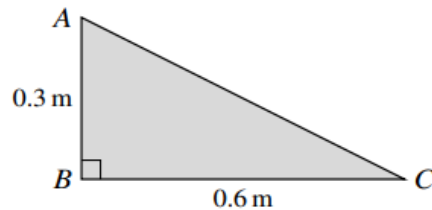
Q1.



The diagram shows the cross-section through the centre of mass of a uniform solid object. The object is a cylinder of radius 0.2 m and length 0.7 m, from which a hemisphere of radius 0.2 m has been removed at one end. The point A is the centre of the plane face at the other end of the object. Find the distance of the centre of mass of the object from A. [5]

[The volume of a hemisphere is $\frac{2}{3}\pi r^3$.]

Q2.



ABC is a uniform lamina in the form of a triangle with $AB = 0.3$ m, $BC = 0.6$ m and a right angle at *B* (see diagram).

(i) State the distances of the centre of mass of the lamina from *AB* and from *BC*. [2]

The lamina is freely suspended at *B* and hangs in equilibrium.

(ii) Find the angle between *AB* and the horizontal. [2]

A force of magnitude 12 N is applied along the edge *AC* of the lamina in the direction from *A* towards *C*. The lamina, still suspended at *B*, is now in equilibrium with *AB* vertical.

(iii) Calculate the weight of the lamina. [3]

Equilibrium of a Rigid Body 1

Q3.

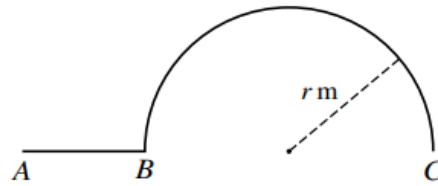


Fig. 1

Fig. 1 shows an object made from a uniform wire of length 0.8 m. The object consists of a straight part AB , and a semicircular part BC such that A , B and C lie in the same straight line. The radius of the semicircle is r m and the centre of mass of the object is 0.1 m from line ABC .

(i) Show that $r = 0.2$.

[3]

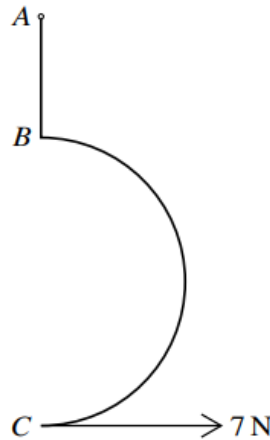


Fig. 2

The object is freely suspended at A and a horizontal force of magnitude 7 N is applied to the object at C so that the object is in equilibrium with ABC vertical (see Fig. 2).

(ii) Calculate the weight of the object.

[3]

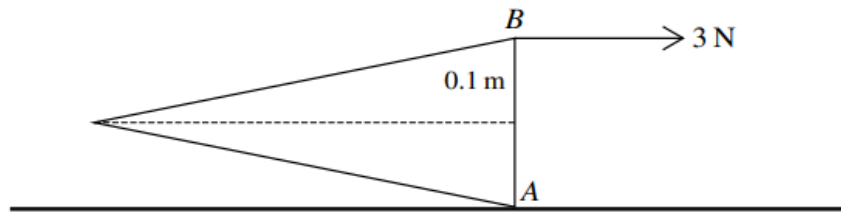
The 7 N force is removed and the object hangs in equilibrium with ABC at an angle of θ° with the vertical.

(iii) Find θ .

[6]

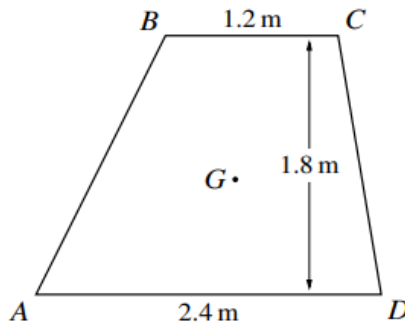
Equilibrium of a Rigid Body 1

Q4.



A uniform solid cone has weight 5 N and base radius 0.1 m . AB is a diameter of the base of the cone. The cone is held in equilibrium, with A in contact with a rough horizontal surface and AB vertical, by a force applied at B . This force has magnitude 3 N and acts parallel to the axis of the cone (see diagram). Calculate the height of the cone. [3]

Q5.



$ABCD$ is a uniform lamina in the shape of a trapezium which has centre of mass G . The sides AD and BC are parallel and 1.8 m apart, with $AD = 2.4\text{ m}$ and $BC = 1.2\text{ m}$ (see diagram).

(i) Show that the distance of G from AD is 0.8 m . [4]

The lamina is freely suspended at A and hangs in equilibrium with AD making an angle of 30° with the vertical.

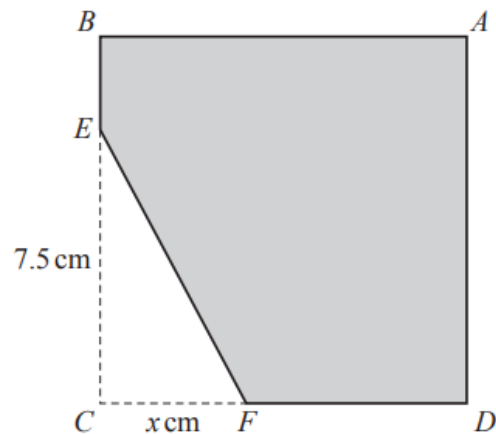
(ii) Calculate the distance AG . [2]

With the lamina still freely suspended at A a horizontal force of magnitude 7 N acting in the plane of the lamina is applied at D . The lamina is in equilibrium with AG making an angle of 10° with the downward vertical.

(iii) Find the two possible values for the weight of the lamina. [5]

Equilibrium of a Rigid Body 1

Q6.



A uniform square lamina $ABCD$ has sides of length 10 cm. The point E is on BC with $EC = 7.5$ cm, and the point F is on DC with $CF = x$ cm. The triangle EFC is removed from $ABCD$ (see diagram). The centre of mass of the resulting shape $ABEFD$ is a distance \bar{x} cm from CB and a distance \bar{y} cm from CD .

- (a) Show that $\bar{x} = \frac{400 - x^2}{80 - 3x}$ and find a corresponding expression for \bar{y} . [4]

The shape $ABEFD$ is in equilibrium in a vertical plane with the edge DF resting on a smooth horizontal surface.

- (b) Find the greatest possible value of x , giving your answer in the form $a + b\sqrt{2}$, where a and b are constants to be determined. [3]