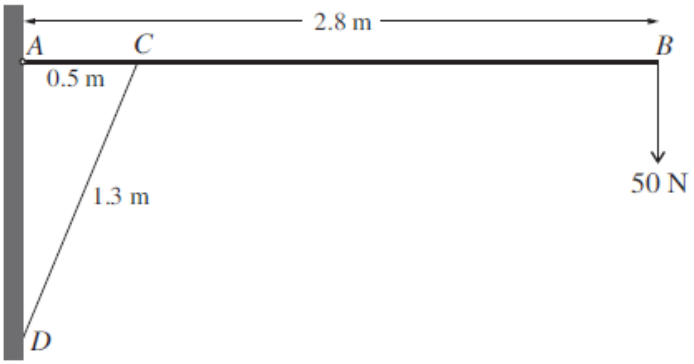
Topic X4 Centre of mass (Post-TT B) [34]

1.

The region R is bounded by the x-axis, the lines $x = a$ and $x = 2a$, and the curve $y = \frac{a^3}{x^2}$ for $a \leqslant x \leqslant 2a$, where a is a positive constant. A uniform solid of revolution is formed by rotating R through 2π radians about the x-axis. Find the x-coordinate of the centre of mass of this solid. **[7]**

(Total 7 marks)

2.



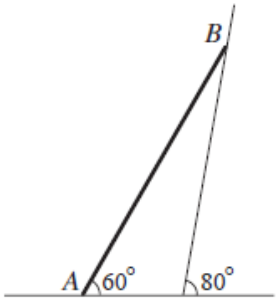
A uniform beam AB has weight 70 N and length 2.8 m. The beam is freely hinged to a wall at A and is supported in a horizontal position by a strut CD of length 1.3 m. One end of the strut is attached to the beam at C, 0.5 m from A, and the other end is attached to the wall at D, vertically below A. The strut exerts a force on the beam in the direction DC. The beam carries a load of weight 50 N at its end B (see diagram).

(i) Calculate the magnitude of the force exerted by the strut on the beam. **[4]**

(ii) Calculate the magnitude of the force acting on the beam at A. **[6]**

(Total 10 marks)

3.



A uniform rod AB, of weight 25 N and length 1.6 m, rests in equilibrium in a vertical plane with the end A in contact with rough horizontal ground and the end B resting against a smooth wall which is inclined at 80° to the horizontal. The rod is inclined at 60° to the horizontal (see diagram). Calculate the magnitude of the force acting on the rod at B. [6]

(Total 6 marks)

4.

(i)

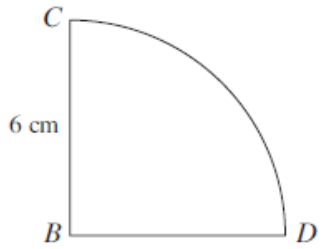


Fig. 1

Fig. 1 shows a uniform lamina BCD in the shape of a quarter circle of radius 6 cm. Show that the distance of the centre of mass of the lamina from B is 3.60 cm, correct to 3 significant figures. **[2]**

A uniform rectangular lamina $ABDE$ has dimensions $AB = 12$ cm and $AE = 6$ cm. A single plane object is formed by attaching the rectangular lamina to the lamina BCD along BD (see Fig. 2). The mass of $ABDE$ is 3 kg and the mass of BCD is 2 kg.

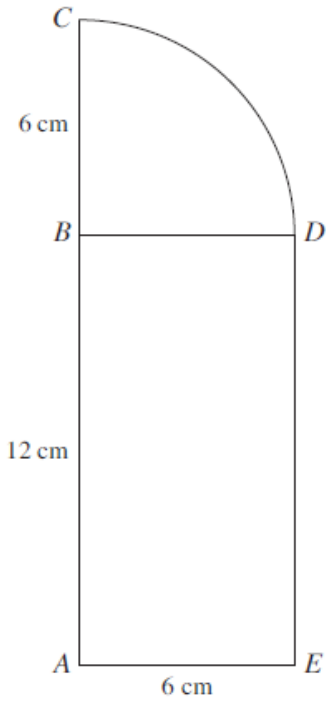


Fig. 2

(ii) Taking x- and y-axes along AE and AB respectively, find the coordinates of the centre of mass of the object. **[7]**

The object is freely suspended at C and rests in equilibrium.

(iii) Calculate the angle that AC makes with the vertical. **[2]**

(Total 11 marks)