3: [*The distance of the centre of mass of a semicircular arc of radius r is* $\frac{2r}{\pi}$ *from its centre.*]

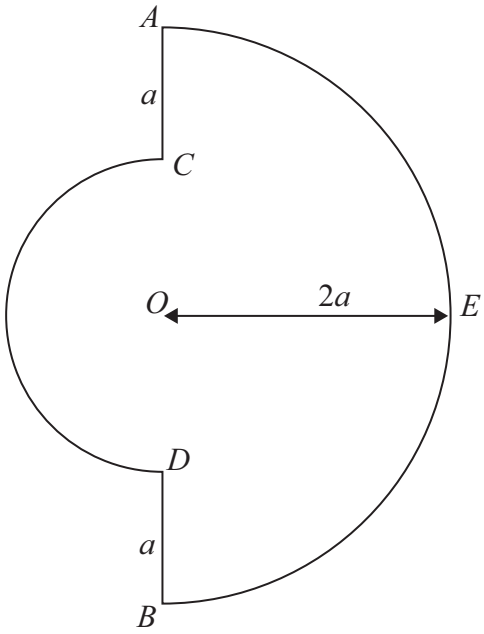


Figure 1

A uniform rigid wire **framework**, shown in Figure 1, consists of two wire semicircular arcs *AB* and *CD*, both with centre *O*, joined by two straight pieces of wire, *AC* and *DB*.

Arc *AB* has radius $2a$, arc *CD* has radius a, $AC = DB = a$, and *ACDB* is a straight line.

The framework lies in a single plane.

(a) Show that the centre of mass of the framework is a distance $\frac{6a}{(3\pi + 2)}$ from *AB*.

(5)

The point *E* is on the arc *AB* and the angle *AOE* is a right angle.

The framework is freely suspended from *A*.

The framework hangs at rest in a vertical plane with ***AE*** making an angle θ with the downward vertical.

(b) Find the exact value of $\tan\theta$, simplifying your answer.

(5)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 3 continued

Question 3 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 3 continued

(Total for Question 3 is 10 marks)