**1.**

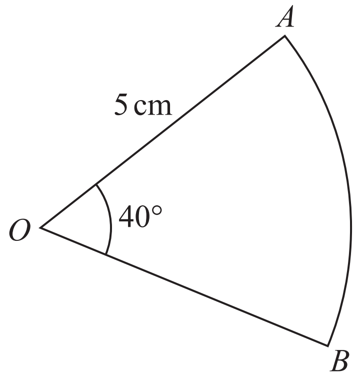


**Figure 1**

Figure 1 shows a sector $AOB$ of a circle with centre $O$, radius 5 cm and angle $AOB = 40°$

The attempt of a student to find the area of the sector is shown below.

$$\text{Area of sector} = \frac{1}{2}r^2\theta$$
$$= \frac{1}{2} \times 5^2 \times 40$$
$$= 500\,\text{cm}^2$$

(a) Explain the error made by this student.

**(1)**

(b) Write out a correct solution.

**(2)**

**2.**

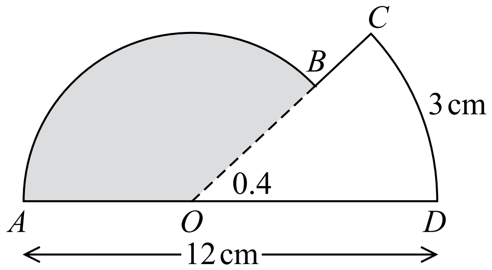


**Figure 1**

The shape *ABCDOA*, as shown in Figure 1, consists of a sector *COD* of a circle centre *O* joined to a sector *AOB* of a different circle, also centre *O*.

Given that arc length *CD* = 3 cm, ∠*COD* = 0.4 radians and *AOD* is a straight line of length 12 cm,

(a) find the length of *OD*,

**(2)**

(b) find the area of the shaded sector *AOB*.

**(3)**

**3.**

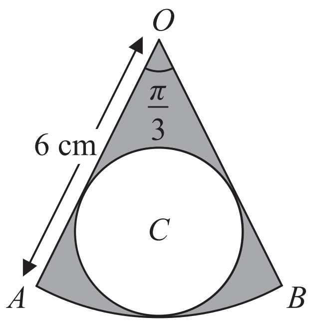


**Figure 1**

The shape shown in Figure 1 is a pattern for a pendant. It consists of a sector $OAB$ of a circle centre $O$, of radius 6 cm, and angle $AOB = \frac{\pi}{3}$. The circle $C$, inside the sector, touches the two straight edges, $OA$ and $OB$, and the arc $AB$ as shown.

Find

(a) the area of the sector $OAB$,

**(2)**

(b) the radius of the circle $C$.

**(3)**

The region outside the circle $C$ and inside the sector $OAB$ is shown shaded in Figure 1.

(c) Find the area of the shaded region.

**(2)**

**4.**

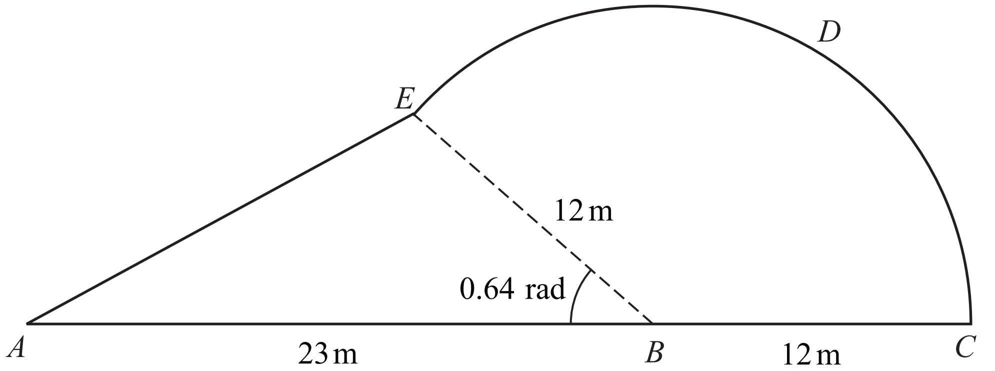


**Figure 2**

Figure 2 shows a plan view of a garden.
The plan of the garden $ABCDEA$ consists of a triangle $ABE$ joined to a sector $BCDE$ of a circle with radius 12 m and centre $B$.
The points $A$, $B$ and $C$ lie on a straight line with $AB = 23$ m and $BC = 12$ m.

Given that the size of angle $ABE$ is exactly 0.64 radians, find

(a) the area of the garden, giving your answer in $m^2$, to 1 decimal place,

**(4)**

(b) the perimeter of the garden, giving your answer in metres, to 1 decimal place.

**(5)**

**5.**

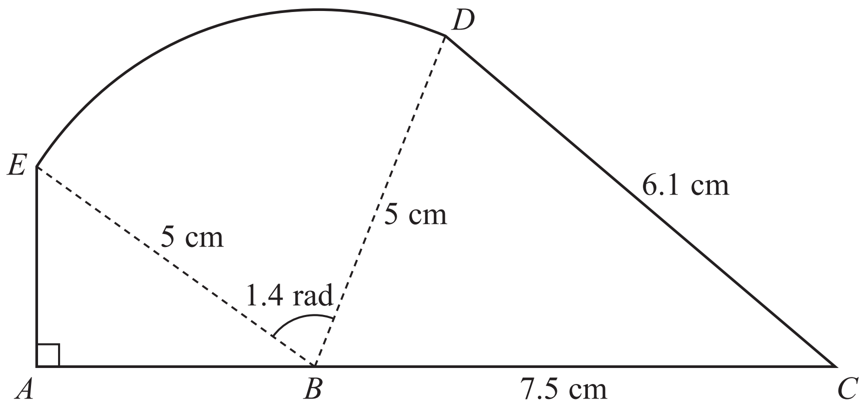


**Figure 2**

The shape *ABCDEA*, as shown in Figure 2, consists of a right-angled triangle *EAB* and a triangle *DBC* joined to a sector *BDE* of a circle with radius 5 cm and centre *B*.

The points *A*, *B* and *C* lie on a straight line with $BC = 7.5$ cm.

Angle $EAB = \dfrac{\pi}{2}$ radians, angle $EBD = 1.4$ radians and $CD = 6.1$ cm.

(a) Find, in $\text{cm}^2$, the area of the sector *BDE*.

**(2)**

(b) Find the size of the angle *DBC*, giving your answer in radians to 3 decimal places.

**(2)**

(c) Find, in $\text{cm}^2$, the area of the shape *ABCDEA*, giving your answer to 3 significant figures.

**(5)**

**6.**

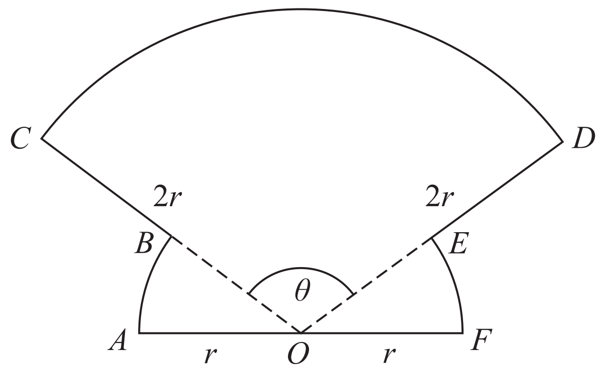


**Figure 1**

The shape *OABCDEFO* shown in Figure 1 is a design for a logo.

In the design

- *OAB* is a sector of a circle centre *O* and radius $r$
- sector *OFE* is congruent to sector *OAB*
- *ODC* is a sector of a circle centre *O* and radius $2r$
- *AOF* is a straight line

Given that the size of angle *COD* is $\theta$ radians,

(a) write down, in terms of $\theta$, the size of angle *AOB*

**(1)**

(b) Show that the area of the logo is

$$\frac{1}{2}r^2(3\theta + \pi)$$

**(2)**

(c) Find the perimeter of the logo, giving your answer in simplest form in terms of $r$, $\theta$ and $\pi$.

**(2)**

**7**

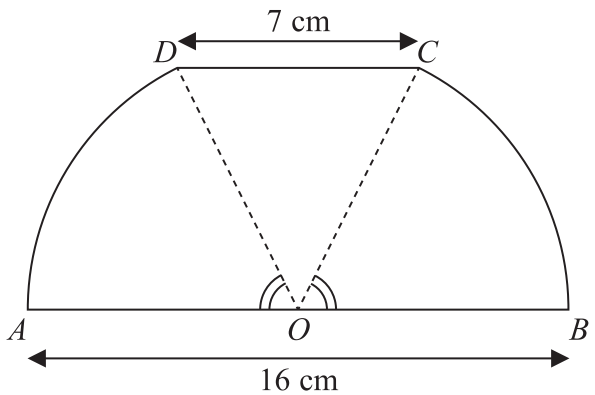


**Figure 1**

Figure 1 shows a sketch of a design for a scraper blade. The blade *AOBCDA* consists of an isosceles triangle *COD* joined along its equal sides to sectors *OBC* and *ODA* of a circle with centre *O* and radius 8 cm. Angles *AOD* and *BOC* are equal. *AOB* is a straight line and is parallel to the line *DC*. *DC* has length 7 cm.

(a) Show that the angle *COD* is 0.906 radians, correct to 3 significant figures.

**(2)**

(b) Find the perimeter of *AOBCDA*, giving your answer to 3 significant figures.

**(3)**

(c) Find the area of *AOBCDA*, giving your answer to 3 significant figures.

**(3)**

**8.**

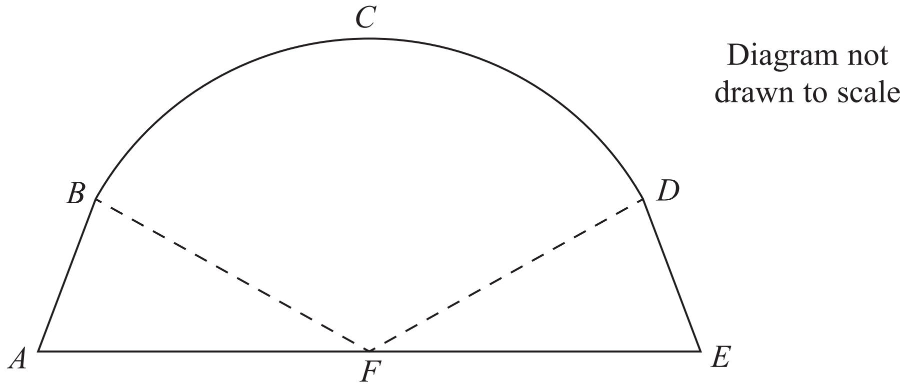


**Figure 1**

Figure 1 is a sketch representing the cross-section of a large tent *ABCDEF*.
*AB* and *DE* are line segments of equal length.
Angle *FAB* and angle *DEF* are equal.
*F* is the midpoint of the straight line *AE* and *FC* is perpendicular to *AE*.
*BCD* is an arc of a circle of radius 3.5 m with centre at *F*.
It is given that

$$AF = FE = 3.7\text{m}$$

$$BF = FD = 3.5\text{m}$$

$$\text{angle } BFD = 1.77 \text{ radians}$$

Find

(a) the length of the arc *BCD* in metres to 2 decimal places,

**(2)**

(b) the area of the sector *FBCD* in $m^2$ to 2 decimal places,

**(2)**

(c) the total area of the cross-section of the tent in $m^2$ to 2 decimal places.

**(4)**

**9.**

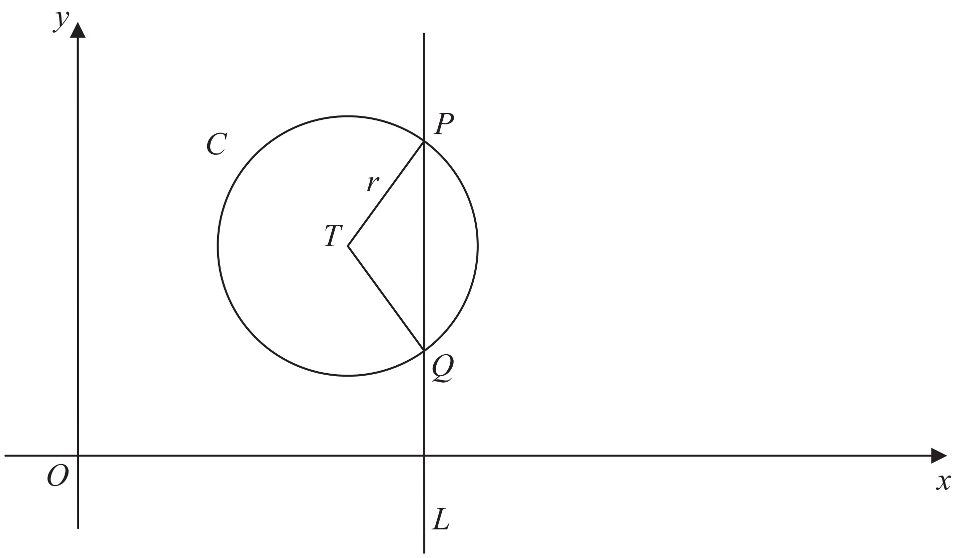


**Figure 1**

The circle $C$ with centre $T$ and radius $r$ has equation

$$x^2 + y^2 - 20x - 16y + 139 = 0$$

(a) Find the coordinates of the centre of $C$.

**(3)**

(b) Show that $r = 5$

**(2)**

The line $L$ has equation $x = 13$ and crosses $C$ at the points $P$ and $Q$ as shown in Figure 1.

(c) Find the $y$ coordinate of $P$ and the $y$ coordinate of $Q$.

**(3)**

Given that, to 3 decimal places, the angle $PTQ$ is 1.855 radians,

(d) find the perimeter of the sector $PTQ$.

**(3)**

**10.**

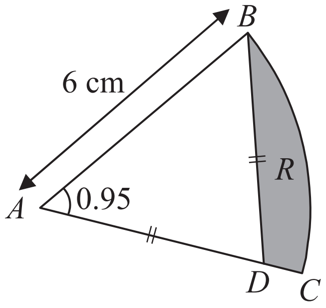


**Figure 2**

Figure 2 shows $ABC$, a sector of a circle of radius 6 cm with centre $A$. Given that the size of angle $BAC$ is 0.95 radians, find

(a) the length of the arc $BC$,

**(2)**

(b) the area of the sector $ABC$.

**(2)**

The point $D$ lies on the line $AC$ and is such that $AD = BD$. The region $R$, shown shaded in Figure 2, is bounded by the lines $CD$, $DB$ and the arc $BC$.

(c) Show that the length of $AD$ is 5.16 cm to 3 significant figures.

**(2)**

Find

(d) the perimeter of $R$,

**(2)**

(e) the area of $R$, giving your answer to 2 significant figures.

**(4)**

**11.**

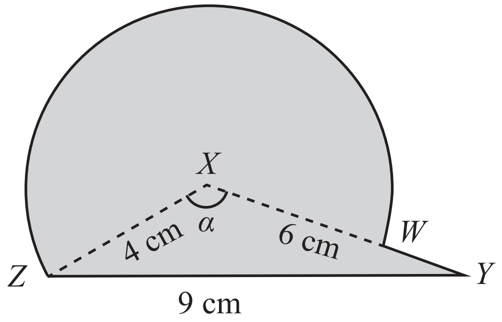


**Figure 1**

The triangle $XYZ$ in Figure 1 has $XY = 6$ cm, $YZ = 9$ cm, $ZX = 4$ cm and angle $ZXY = \alpha$. The point $W$ lies on the line $XY$.

The circular arc $ZW$, in Figure 1 is a major arc of the circle with centre $X$ and radius 4 cm.

(a) Show that, to 3 significant figures, $\alpha = 2.22$ radians.

**(2)**

(b) Find the area, in $\text{cm}^2$, of the major sector $XZWX$.

**(3)**

The region enclosed by the major arc $ZW$ of the circle and the lines $WY$ and $YZ$ is shown shaded in Figure 1.

Calculate

(c) the area of this shaded region,

**(3)**

(d) the perimeter $ZWYZ$ of this shaded region.

**(4)**

**12.**

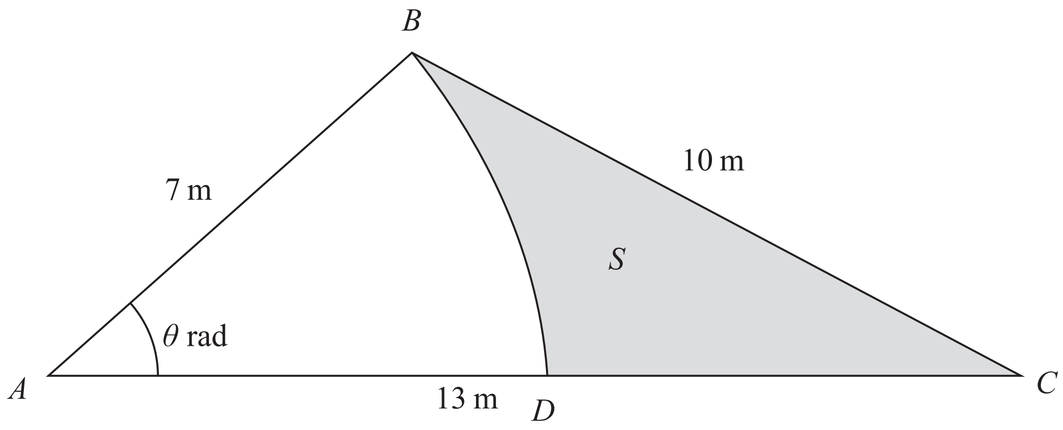


**Figure 2**

Figure 2 shows the design for a triangular garden $ABC$ where $AB = 7$ m, $AC = 13$ m and $BC = 10$ m.

Given that angle $BAC = \theta$ radians,

(a) show that, to 3 decimal places, $\theta = 0.865$

**(3)**

The point $D$ lies on $AC$ such that $BD$ is an arc of the circle centre $A$, radius 7 m.

The shaded region $S$ is bounded by the arc $BD$ and the lines $BC$ and $DC$. The shaded region $S$ will be sown with grass seed, to make a lawned area.

Given that 50 g of grass seed are needed for each square metre of lawn,

(b) find the amount of grass seed needed, giving your answer to the nearest 10 g.

**(7)**

**13.**

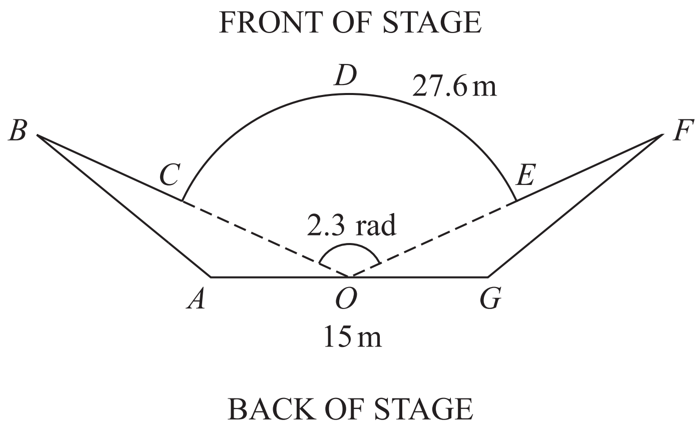


Diagram **NOT** accurately drawn

**Figure 1**

Figure 1 shows the plan view of a stage.

The plan view shows two congruent triangles $ABO$ and $GFO$ joined to a sector $OCDEO$ of a circle, centre $O$, where

- angle $COE = 2.3$ radians
- arc length $CDE = 27.6$ m
- $AOG$ is a straight line of length 15 m

(a) Show that $OC = 12$ m.

**(2)**

(b) Show that the size of angle $AOB$ is 0.421 radians correct to 3 decimal places.

**(2)**

Given that the total length of the front of the stage, $BCDEF$, is 35 m,

(c) find the total area of the stage, giving your answer to the nearest square metre.

**(6)**

**14.**

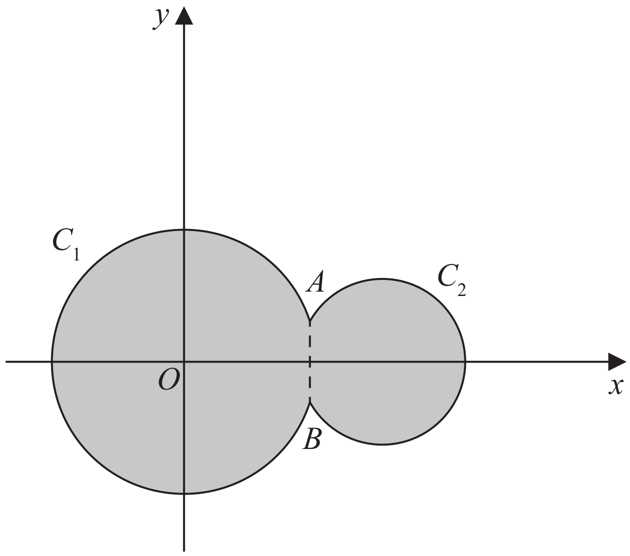


**Figure 3**

Circle $C_1$ has equation $x^2 + y^2 = 100$

Circle $C_2$ has equation $(x - 15)^2 + y^2 = 40$

The circles meet at points $A$ and $B$ as shown in Figure 3.

(a) Show that angle $AOB = 0.635$ radians to 3 significant figures, where $O$ is the origin.

**(4)**

The region shown shaded in Figure 3 is bounded by $C_1$ and $C_2$

(b) Find the perimeter of the shaded region, giving your answer to one decimal place.

**(4)**

**15.**

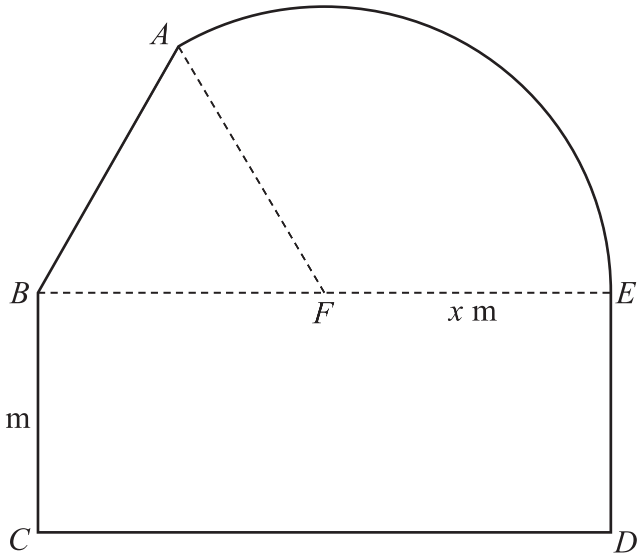


Diagram not drawn to scale

**Figure 4**

Figure 4 shows a plan view of a sheep enclosure.

The enclosure *ABCDEA*, as shown in Figure 4, consists of a rectangle *BCDE* joined to an equilateral triangle *BFA* and a sector *FEA* of a circle with radius $x$ metres and centre *F*.

The points *B*, *F* and *E* lie on a straight line with $FE = x$ metres and $10 \leqslant x \leqslant 25$

(a) Find, in $\text{m}^2$, the exact area of the sector *FEA*, giving your answer in terms of $x$, in its simplest form.

**(2)**

Given that $BC = y$ metres, where $y > 0$, and the area of the enclosure is $1000\,\text{m}^2$,

(b) show that

$$y = \frac{500}{x} - \frac{x}{24}\left(4\pi + 3\sqrt{3}\right)$$

**(3)**

(c) Hence show that the perimeter $P$ metres of the enclosure is given by

$$P = \frac{1000}{x} + \frac{x}{12}\left(4\pi + 36 - 3\sqrt{3}\right)$$

**(3)**

(d) Use calculus to find the minimum value of $P$, giving your answer to the nearest metre.

**(5)**

(e) Justify, by further differentiation, that the value of $P$ you have found is a minimum.

**(2)**