

- 1 A bird flies at a constant speed of 12 km/h in still air. When it flies from its nest to a point 32 km away, its speed is increased by x km/h due to a tailwind (in the same direction as the bird)
- (a) Write down, in terms of x , an expression for the time taken for the outward journey. [1]
- (b) On the return journey, the bird's speed is reduced by $(x-1)$ km/h due to a head-wind (opposing the direction of the bird). Write down in terms of x , an expression for the time taken for the return journey. [1]
- (c) Given that the return journey took 75 minutes longer than the outward journey, form an equation in x and show that it simplifies to $5x^2 + 251x - 908 = 0$. [3]
- (d) Solve this equation and find the time taken by the bird for its return journey. [4]

- 2 GreenEnergy Power supplies two types of solar panels, Standard, S and Premium, P to two warehouses, North warehouse and South warehouse.

At the beginning of the year 2025, the North warehouse has 120 Standard panels and 80 Premium panels. The South warehouse has 150 Standard panels and 60 Premium panels.

This information can be represented by matrix $\underset{S}{A} = \overset{N}{\begin{pmatrix} 120 & 80 \\ 150 & 60 \end{pmatrix}}$, where it shows the inventory levels at the two warehouses.

In February 2025, the company shipped additional stock to the warehouses, 40 Standard panels and 30 Premium panels to the North warehouse and 50 Standard panels and 20 Premium panels to the North warehouse.

This information can be represented by matrix $\mathbf{B} = \begin{pmatrix} 40 & 30 \\ 50 & 20 \end{pmatrix}$, where it represents the specific additional stock to the two warehouses.

By the end of March 2025, the sales of each type of panels recorded at each warehouse, is represented by matrix $\mathbf{C}$. Given that the North warehouse sold 100 Standard panels and 75 Premium panels, the South warehouse sold 130 Standard panels and 50 Premium panels.

- (a) Represent this information in a 2×2 matrix $\mathbf{C}$. [1]
- (b) Calculate the final inventory matrix $\mathbf{F}$, where $\mathbf{F} = (\mathbf{A} + \mathbf{B}) - \mathbf{C}$. [3]

[Turn Over

The unit sale price and the unit cost price for each panel type are given in the table below:

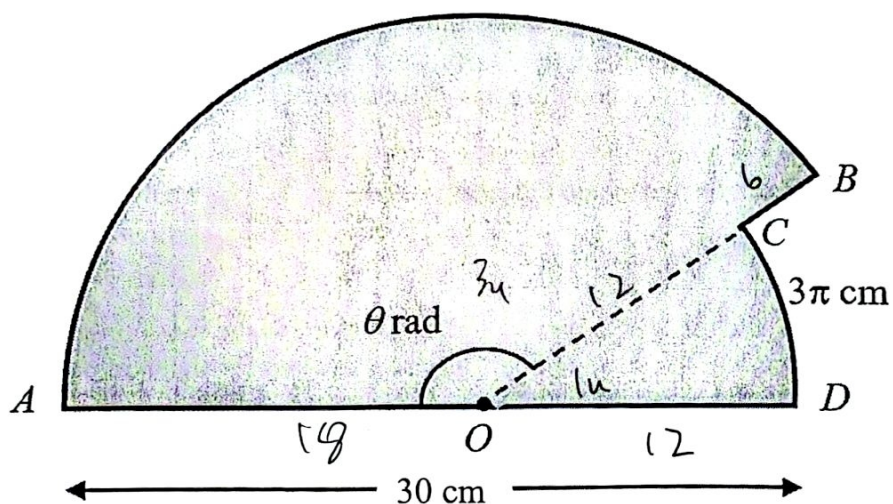
Panel type	Sale price (\$)	Cost price (\$)
Standard, S	400	250
Premium, P	700	450

(c) Represent the above information in a 2×2 matrix T . [1]

(d) Evaluate matrix $R = CT$, and hence determine the total profit generated by the North warehouse. [4]

- 3 The diagram below shows the design of a company logo.
 OCD and OAB are sectors of two circles with a common centre O .
 AOD and OCB are straight lines.

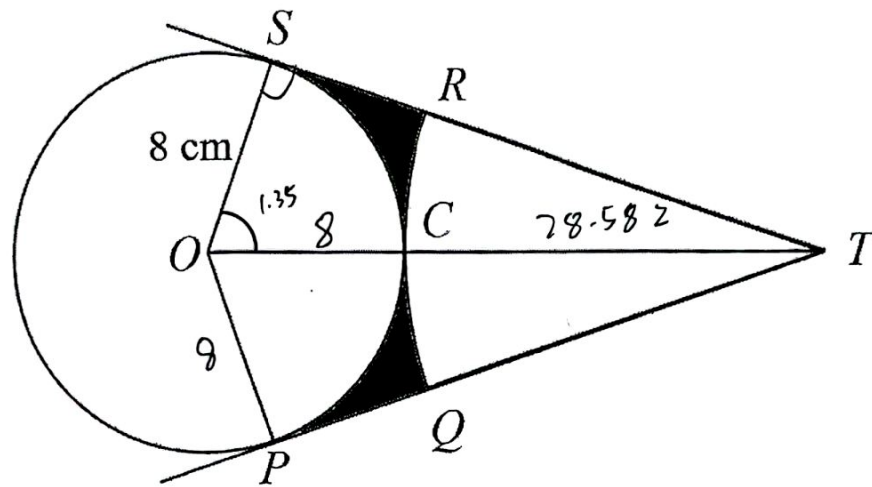
Arc $CD = 3\pi$ cm, $AD = 30$ cm and angle $AOB = \theta$ radians.
The ratio of angle AOB : angle $COD = 3 : 1$.



(a) Show that length $OD = 12$ cm. [2]

(b) Find the perimeter of the design, express your answer in the form $(a\pi + b)$ cm where a and b are constants. [3]

- 4 TP and TS are tangents to the circle with centre O and radius 8 cm. RTQ is a sector of another circle with centre T . The arc of the sector touches the circumference of the circle at the point C . Given that the area of the minor sector OSP is 86.4 cm^2 .



- (a) Find the angle SOT in radians. [2]
- (b) Find the length of TC . [2]
- (c) Calculate the area of the shaded region. [3]

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1) (a) $\frac{32}{12+x} h$

-A

$$1) b \quad \frac{\cancel{32}}{\cancel{12-x} - \cancel{(x-1)}} \quad \frac{32}{12-(x-1)} = \frac{32}{13-x} h$$

statement

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$$1) \frac{32}{12+x} + \frac{5}{4} = \frac{32}{12-x}$$

$$32(13-x) + 75(12+x)(13-x) = 32(12+x)$$

~~$$416 - 32x + 75(156 + x - x^2) = 384 + 32x -$$~~

$$\frac{416 - 32x + 11700 + 75x - 75x^2}{-75x^2 - 32x + 75x - 32x} = 384 + 32x$$

$$32(13-x)(4) + 5(13-x)(12+x) = 32(4)(12+x)$$

$$1664 - 128x + 5(156 + x - x^2) = 1536 + 128x$$

$$1664 - 128x + 780 + 5x - 5x^2 - 1536 - 128x = 0$$

$$1) d \quad 5x^2 + 251 - 908 = 0$$

$$x = \frac{-251 + \sqrt{251^2 - 4(908)(5)}}{2(5)}$$

$$x = 3.3888 \text{ Ans}$$

$$x = \frac{26 - 251 - \sqrt{251^2 - 4(-908)(5)}}{2(5)}$$

$$x = -53.589$$

$$\begin{array}{r} 32 \\ 13 \overline{) 3.3888} = 3.3294 \text{ h} \end{array}$$

~~0.3294 \times 60 =~~

$$= 3.33 \text{ h}$$

$$-5x^2 + 5x - 128x - 128x + 11664 + 780 - 1536 = 0$$

$$5x^2 - 251 + 908 = 0$$

$$5x^2 + 257 - 908 = 0 \text{ (shown)}$$

3

4

2) (a)

$$\begin{pmatrix} 120 & 80 \\ 150 & 60 \end{pmatrix} + \begin{pmatrix} 40 & 30 \\ 50 & 20 \end{pmatrix} = \begin{pmatrix} 160 & 110 \\ 200 & 80 \end{pmatrix}$$

$$C = \begin{pmatrix} 100 & 75 \\ 130 & 50 \end{pmatrix}$$

$$F = \begin{pmatrix} 160 & 110 \\ 200 & 80 \end{pmatrix} - \begin{pmatrix} 100 & 75 \\ 130 & 50 \end{pmatrix} = \begin{pmatrix} 60 & 35 \\ 70 & 30 \end{pmatrix}$$

1

2) b $F = \begin{pmatrix} 120 & 80 \\ 150 & 60 \end{pmatrix} + \begin{pmatrix} 40 & 30 \\ 50 & 20 \end{pmatrix} - \begin{pmatrix} 100 & 75 \\ 130 & 50 \end{pmatrix}$

$$F = \begin{pmatrix} 160 & 110 \\ 200 & 80 \end{pmatrix} - \begin{pmatrix} 100 & 75 \\ 130 & 50 \end{pmatrix} = \begin{pmatrix} 60 & 35 \\ 70 & 30 \end{pmatrix}$$

3

2) c $T = \begin{pmatrix} 400 & 250 \\ 700 & 450 \end{pmatrix}$

1

2) d $R = \begin{pmatrix} 100 & 75 \\ 130 & 50 \end{pmatrix} \begin{pmatrix} 400 & 250 \\ 700 & 450 \end{pmatrix}$

$2 \times 2 \quad \quad 2 \times 2$

$$R = \begin{pmatrix} 100 \times 400 + 75 \times 700 & 100 \times 250 + 75 \times 450 \\ 130 \times 400 + 50 \times 700 & 130 \times 250 + 50 \times 450 \end{pmatrix}$$

$$R = \begin{pmatrix} 92500 & 58750 \\ 87000 & 58900 \end{pmatrix}$$

$$250 \times (100) + 450 \times (75) = 58750$$

$$400 \times (100) + 700 \times (75)$$

The total profit generated by the North warehouse = $92500 - 58750 = 33750$

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3) a ~~$x \times OD = 3\pi$~~
 $\angle COD = x$ $\angle AOB = 3x$
 ~~$x \times OD = 3\pi$~~
 $4x = 180$

3) b $x = 45$ $\angle COD = 45^\circ$
 $\frac{45}{180} \times \pi = \frac{45}{360} \times \pi \times r^2 = 3\pi$ ~~$\frac{45}{180} \times \pi = 0.78540 \text{ (rad)}$~~
 $0.78540 \times r = 9.4248 \text{ (s.s.f.)}$
 $r = 12 \text{ cm (shown)}$
 $\frac{45}{360} = \frac{3\pi}{\pi r^2}$
 $360(3\pi) = 45\pi r^2$
 $3392.4 =$

3) b $45^\circ \times 3 = 135^\circ$
 $30 - 12 = 18$
 $\frac{135}{180} \times \pi = \frac{3\pi}{4}$ $\frac{3\pi}{4} \times 18 = \frac{27\pi}{2}$
 $\frac{27\pi}{2} + 3\pi = \frac{33\pi}{2}$
 $\frac{3\pi}{4} \times 18 \approx 42.412 \text{ (s.s.f.)}$ $= 16.5\pi$
 $42.412 + 30 = 72.412$ $30 + 6 = 36$
 $18 - 12 = 6$
 $72.412 + 6 = 78.412$

The ~~perim~~ perimeter of the design is $(16.5\pi + 36) \text{ cm}$
 $a = 16.5$ $b = 36$

4)a

$$\frac{1}{2}(\angle S O P)(8^2) = 86.4$$

$$\angle S O P = 2.7(\text{rad})$$

$$\angle S O T = 1.35(\text{rad}), , , \checkmark$$

2

4)b

$$\frac{1.35}{\pi} \times 180 = 77.349 (\text{deg.})$$

~~cos~~ $\angle S O T$

$$\cos(77.349^\circ) = \frac{8}{T O} \checkmark$$

$$T O = \frac{8}{\cos(77.349^\circ)}$$

$$T O = 36.528 \text{ cm (5 s.f.)}$$

$$T L = 36.528 - 8$$

$$= 28.528$$

$$= 28.5 \text{ cm (to 3 s.f.)} \checkmark$$

~~28.5~~

A ~~1~~

2

~~1~~

4)c

$$\text{Area of } S O T = \frac{1}{2}(8)(28.528) \sin(77.349^\circ)$$

$$= 111.55 \text{ cm}^2$$

$\rightarrow$ sector

$$\text{Area of } S O P T = 111.55 \times 2$$

$$= 223.1 \text{ cm}^2$$

$$2\left(\frac{1}{2}(8)\sqrt{36.528^2 - 8^2} - 43.2\right) - \frac{1}{2}(28.528)^2\left(\frac{\pi}{2} - 1.35\right) = 19.0 \text{ cm}^2$$

$\rightarrow$ sector

$$\text{Area of } S O P C = \frac{1}{2}(2.7)(8^2)$$

$$= 86.4 \text{ cm}^2 (\text{given})$$

~~Area of TRCQ =~~

$$\angle R T C \text{ ~~TRCQ~~ = } 180 - 90 - 77.349$$

$$= 12.651$$

$$\angle R T Q = 12.651 \times 2$$

$$= 25.302^\circ \checkmark$$

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Nothing is to be written on this margin

$$\frac{25.302}{180} \times \pi = 0.44160 \text{ (rad)}$$

$$\begin{aligned} \text{Area of TRCQ} &= \frac{1}{2} (0.44160) (28.582)^2 \\ &= 180.38 \text{ cm}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of the shaded region} &= 223.1 - 180.38 - 86.4 \\ &= 43.68 \text{ cm}^2 \end{aligned}$$