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# **NATIONAL SENIOR CERTIFICATE**

## **GRADE 12**

### **SEPTEMBER 2024**

## **TECHNICAL MATHEMATICS P2**

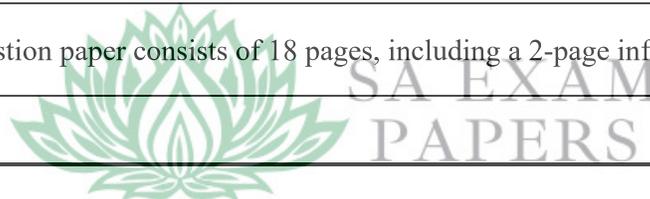
**MARKS:** 150

**TIME:** 3 hours

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This question paper consists of 18 pages, including a 2-page information sheet.

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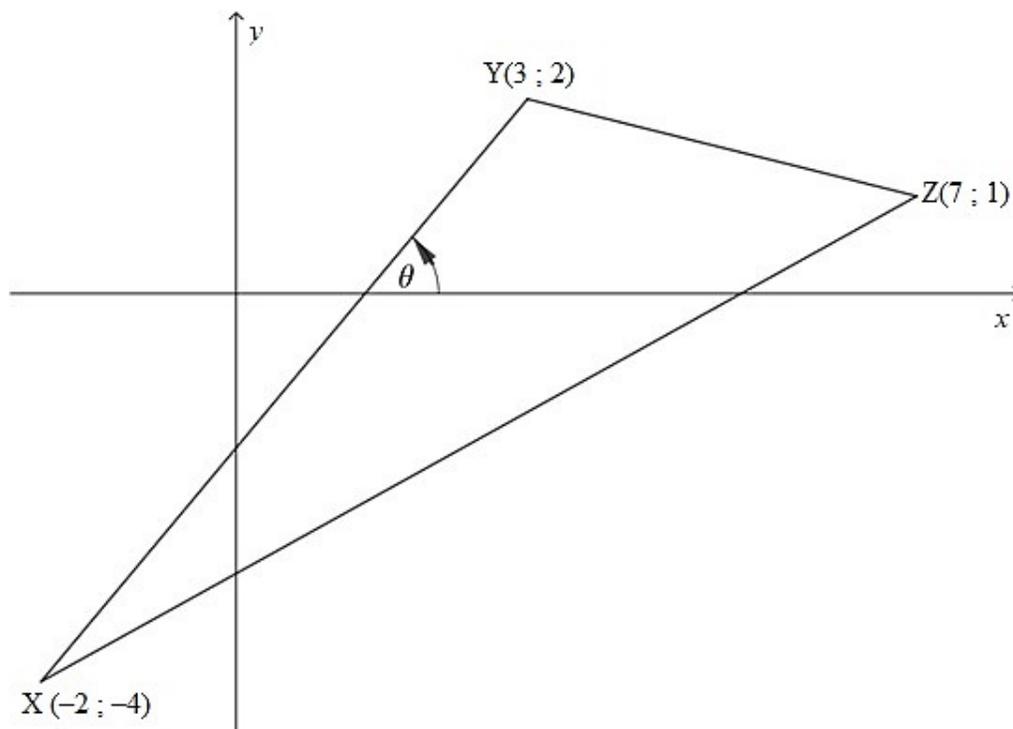
**INSTRUCTIONS AND INFORMATION**

Read the following instructions carefully before answering the questions.

1. This question paper consists of 11 questions.
2. Answer ALL the questions in the SPECIAL ANSWER BOOK provided.
3. Clearly show ALL calculations, diagrams, graphs, et cetera that you have used in determining the answers.
4. Answers only will NOT necessarily be awarded full marks.
5. If necessary, round off your answers to TWO decimal places, unless stated otherwise.
6. Diagrams are NOT necessarily drawn to scale.
7. You may use an approved scientific calculator (non-programmable and non-graphical) unless stated otherwise.
8. An information sheet with formulae is included at the end of the question paper.
9. Write neatly and legibly.

**QUESTION 1**

The diagram below is of  $\triangle XYZ$  with vertices  $X(-2; -4)$ ;  $Y(3; 2)$  and  $Z(7; 1)$ . The angle of inclination of line  $XY$  with the positive  $x$ -axis is  $\theta$ .

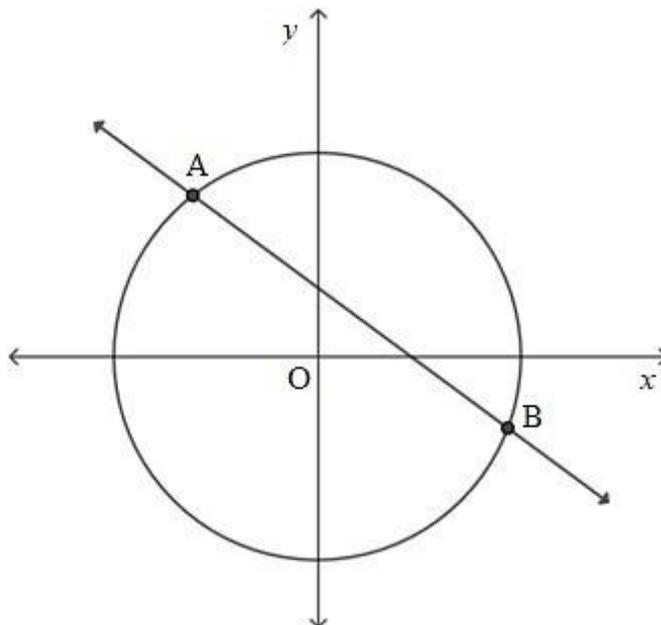


- 1.1 Calculate the gradient of line XY. (2)
- 1.2 Calculate the length of line XY. (3)
- 1.3 Determine the size of  $\theta$  to TWO decimal places. (3)
- 1.4 Determine the equation of the line passing through midpoint M of line YZ, and parallel to line XY. (5)

**[13]**

## QUESTION 2

- 2.1 In the diagram below,  $O(0; 0)$  is the centre of the circle defined by  $x^2 + y^2 = 40$ . A and B are points on the circle such that the line  $y = -x + 4$  is drawn passing through them.



- 2.1.1 What is the name given to the line passing through points A and B? (1)
- 2.1.2 Calculate the coordinates of A and B. (4)
- 2.1.3 Determine the equation of the tangent passing through point A. (4)

- 2.2 As a Technical Mathematics student who is fascinated about how things are made and how you can apply your technical skills, your attention was drawn to a rugby ball, as depicted in the picture below.



2.2.1 What type of shape is a rugby ball? (1)

2.2.2 As you were analysing the shape of the rugby ball, you came up with the equation  $16x^2 + 64y^2 = 1\ 024$ . Express the equation in the form:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1. \quad (2)$$

2.2.3 Sketch on the grid provided, in your ANSWER BOOK, the graph defined by  $16x^2 + 64y^2 = 1\ 024$ . Clearly show all the intercepts with the axes. (3)

[15]

**QUESTION 3**

3.1 Given:  $\theta = 22,51^\circ$  and  $\beta = 231,21^\circ$ .

Determine:  $\cos(\theta + 20^\circ) - \tan(3\beta)$  (2)

3.2 Given that  $4 \cos \alpha + 4 = 7$  and that  $\tan \alpha < 0$ , with the aid of a diagram, evaluate without using a calculator:

3.2.1  $\sin \alpha$  (4)

3.2.2  $\tan \alpha + \frac{\operatorname{cosec}^2 \alpha}{3}$  (3)

3.3 Solve for  $x$  if  $3 \sin x + 2 = 0$  and  $x \in [0^\circ ; 360^\circ]$ . (5)  
**[14]**

**QUESTION 4**

4.1 Simplify the following:

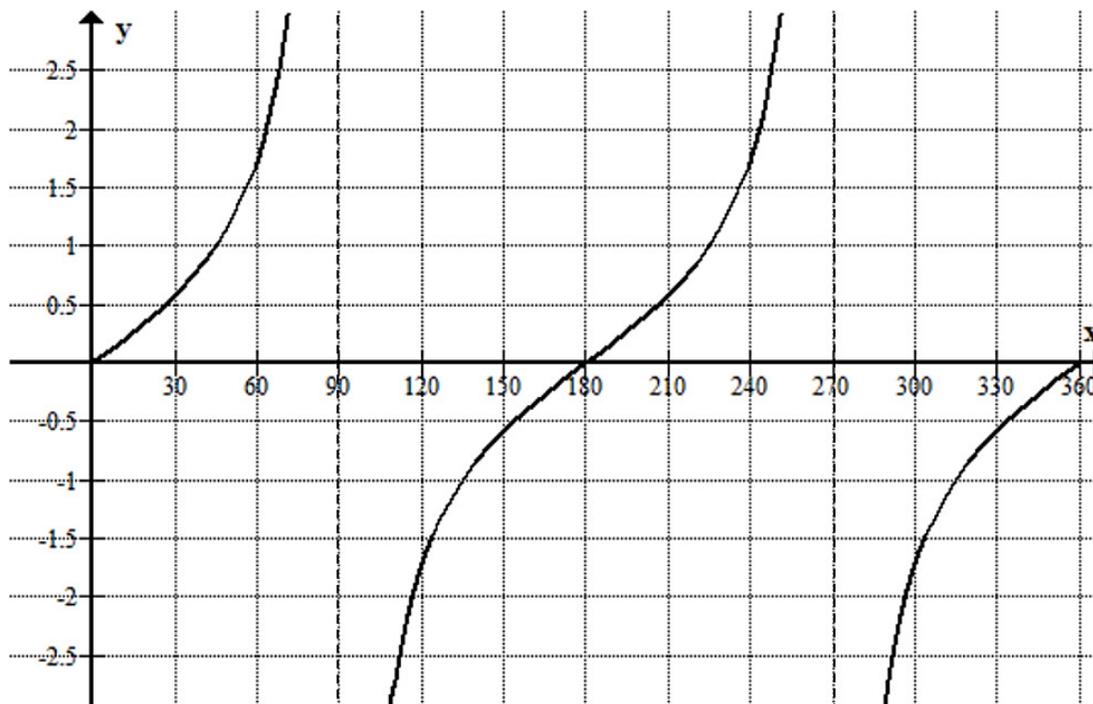
4.1.1  $\cot(2\pi - \theta)$  (1)

4.1.2 
$$\frac{\tan(360^\circ - \theta) \cdot \cos(360^\circ - \theta) \cdot \sin \theta}{\sin(180^\circ - \theta) \cdot \cot(2\pi - \theta) \cdot \sec(360^\circ + \theta)}$$
 (7)

4.2 Prove that:  $\tan x \sin^2 x + \sin x \cos x = \tan x$  (5)  
**[13]**

## QUESTION 5

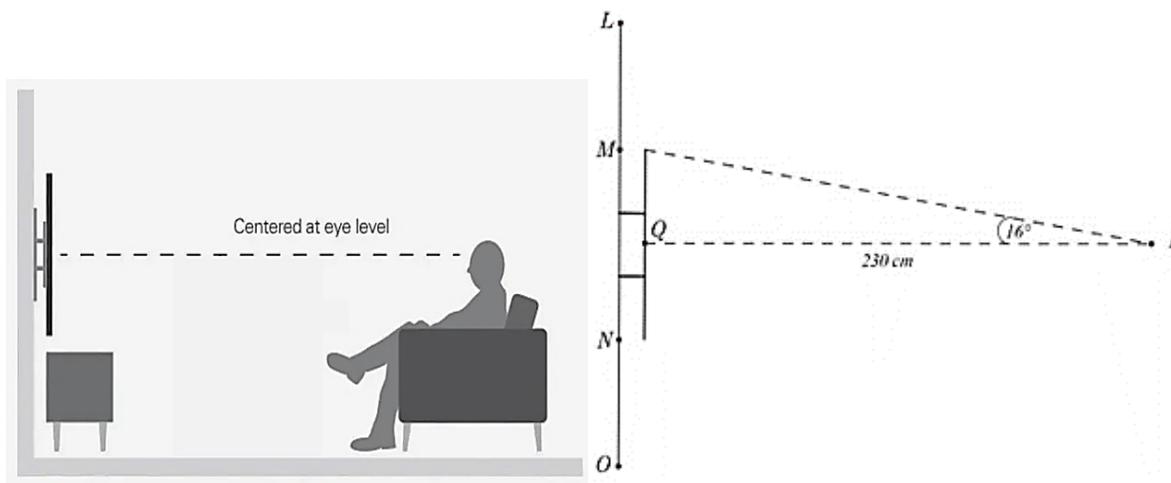
The diagram below shows the graph of  $f(x) = \tan x$  for  $x \in [0^\circ ; 360^\circ]$ .



- 5.1 In the ANSWER BOOK provided, sketch the graph of  $g(x) = 2 \sin(x + 30^\circ)$ , for  $x \in [0^\circ ; 360^\circ]$ . Clearly show all the turning points, starting and end points, and also intercepts with the axes. (3)
- 5.2 Using the graphs determine the following:
- 5.2.1 The period of  $f$  (1)
- 5.2.2 The value of  $x$  where  $\tan x$  is undefined. (2)
- 5.2.3 The range of  $g$  (2)
- 5.2.4 The amplitude of  $g$  (1)
- 5.3 Determine the values of  $x$  for which  $f(x) \cdot g(x) > 0$ . (3)
- [12]

## QUESTION 6

As a flat-screen TV technician, you want to give your customers the best service. This encourages you to ensure that every installation you do, meets specific criteria. The picture below shows the proper installation for a flat-screen TV, where the centre of the flat-screen TV must be at eye level. The diagram below, on the right, models the setup. LO is the height of the wall; MN is the height of the flat-screen TV.  $\widehat{MPQ} = 16^\circ$  and  $PQ = 230$  cm.

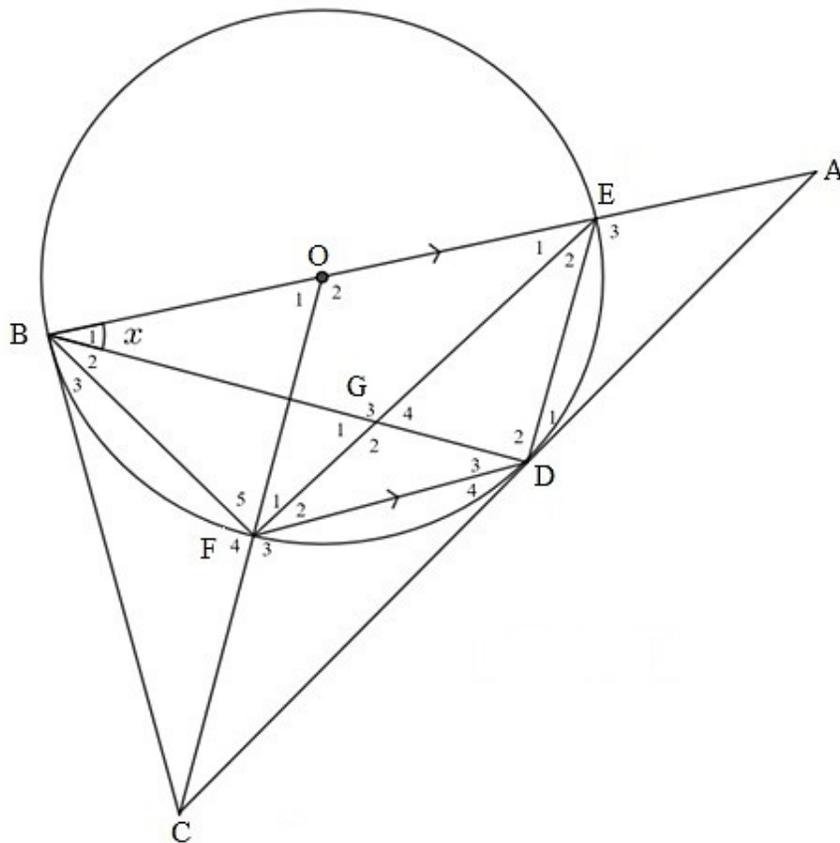


- 6.1 Define:  $\tan \theta = \dots$  (1)
- 6.2 Calculate MN, the height of the flat-screen TV. (3)
- 6.3 Calculate the area of the  $\triangle MNP$ . (3)
- 6.4 It takes 125 minutes to install one flat-screen TV in a room. The technician charges R350,00 per hour for installations.
- 6.4.1 How long will it take the technician to install flat-screen TVs in a B&B with 15 rooms? Give your answer in days. (3)
- 6.4.2 How much will he get paid for the installation job? Take note that the technician's workday is 8 hours. (1)

**[11]**

**QUESTION 7**

In the diagram below BC and ADC are tangents to a circle with centre O, which meet at C. Points B, F, D and E are points on the circle. BOEA is a straight line.  $BA \parallel FD$  and  $\widehat{OBD} = x$ .

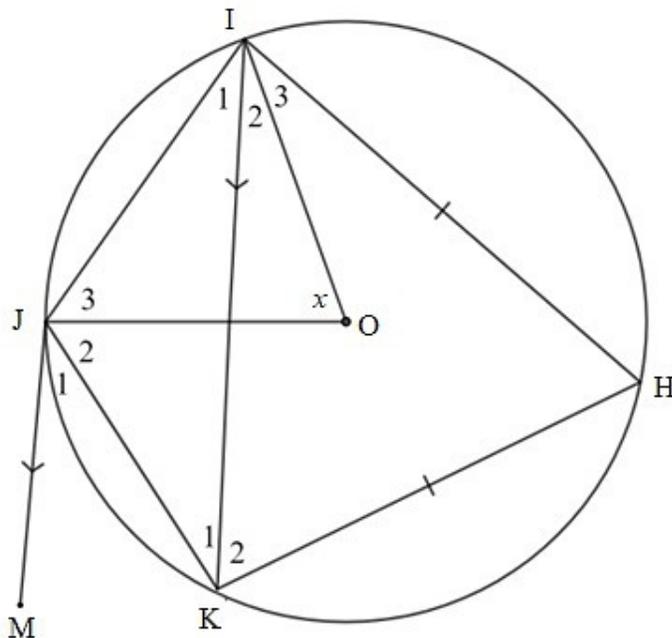


- 7.1 Give, with reasons, THREE angles equal to  $x$ . (6)
- 7.2 State why  $\widehat{OBC} = 90^\circ$  and give any other angle with the same size as  $\widehat{OBC}$ . (2)
- 7.3 If  $x = 23^\circ$  determine the numerical value of  $\hat{A}$ . (5)

**[13]**

**QUESTION 8**

In the diagram below, a circle HIJK with centre  $O$  is drawn.  $JM$  is a tangent to the circle at  $J$ . It is also given that  $HI = HK$ ;  $IK \parallel JM$  and  $\widehat{IOJ} = x$ .



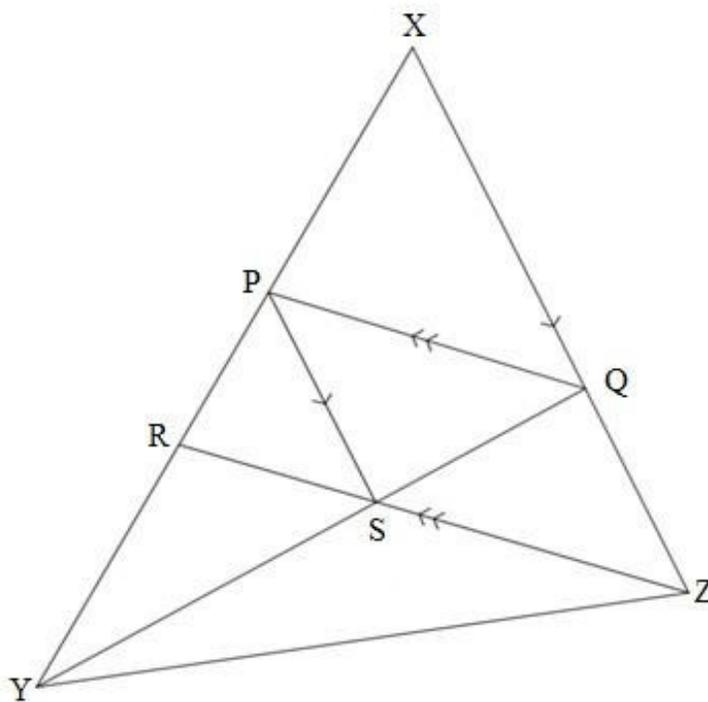
- 8.1 Determine, stating reasons, the size of the angle  $\widehat{K}_1$ , in terms of  $x$ . (2)
  - 8.2 By using information from the diagram:
    - 8.2.1 Show that  $JK = JI$ . (4)
    - 8.2.2 Hence or otherwise, giving reasons, determine the size of  $\widehat{H}$ , in terms of  $x$ . (3)
  - 8.3 Prove that  $\triangle IOJ \parallel \triangle IHK$ . (4)
  - 8.4 Given that  $HK$  is twice  $OJ$ , calculate the length of  $IJ$  if  $HK = 10$  cm and  $IK = 8$  cm. (5)
- [18]**

## QUESTION 9

9.1 Complete the following statement:

“A line drawn ... to one side of a triangle divide the other two sides proportionally.” (1)

9.2 In the diagram below  $XZ \parallel PS$  and  $PQ \parallel RZ$ .



9.2.1 Show that:  $\frac{YR}{RP} = \frac{YP}{PX}$  (3)

9.2.2 Prove that:  $XY \cdot RY = PY^2$  (4)

[8]

**QUESTION 10**

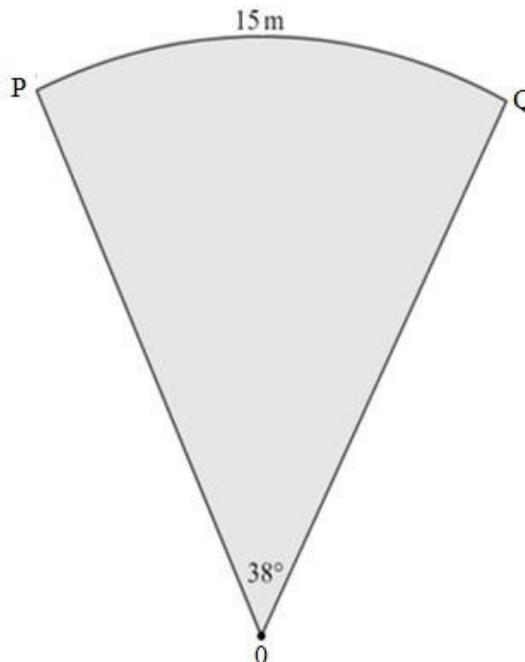
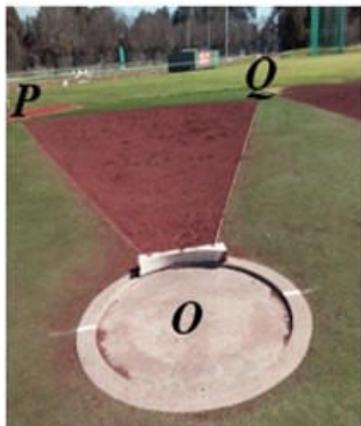
- 10.1 Drone technology is changing rapidly. Drones are often used to record videos from high altitudes. Drones make use of small blades that make them fly, as shown in the picture below.



A drone rotates its blade at 8 000 revs per minute. The length of the blade is 50 mm.

- 10.1.1 Convert 50 mm to metres. (2)
- 10.1.2 Calculate the rotational frequency of the drone in revolutions per second. (2)
- 10.1.3 Calculate its angular velocity. (3)
- 10.1.4 Calculate the peripheral velocity. (4)

- 10.2 A shot-put field has a shape as shown in the picture below. Alongside is the model of the field.



Given that  $\widehat{POQ} = 38^\circ$  and the arc length PQ is 15 m.

10.2.1 Convert  $\widehat{POQ}$  to radians. (1)

10.2.2 Calculate the length of OP. (3)

10.2.3 Determine the area of sector OPQ. (3)

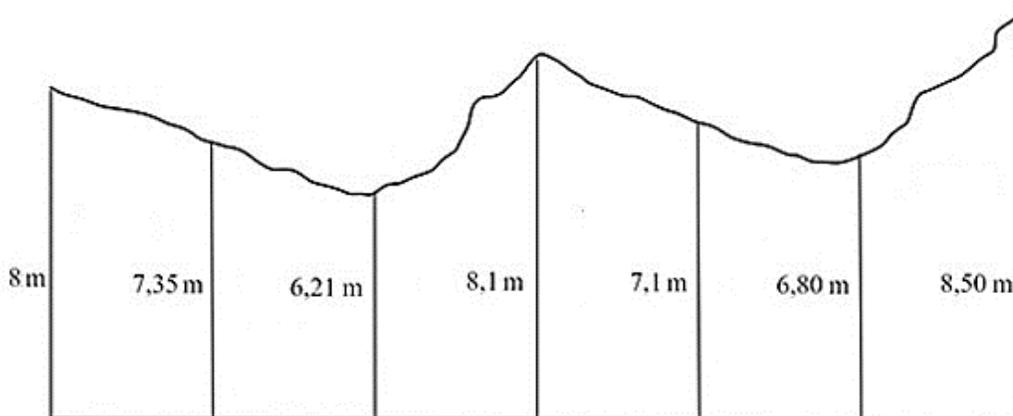
- 10.3 Given is a circle with a diameter 23 cm and a segment height of 5 cm. Calculate the length of the chord that divides the circle into two segments. (4)

[22]

**QUESTION 11**

The irregular figure given below has a flat side with length 36 m and the heights of the ordinates are as follows:

8 m; 7,35 m; 6,21 m; 8,1 m; 7,1 m; 6,80 m and 8,50 m.



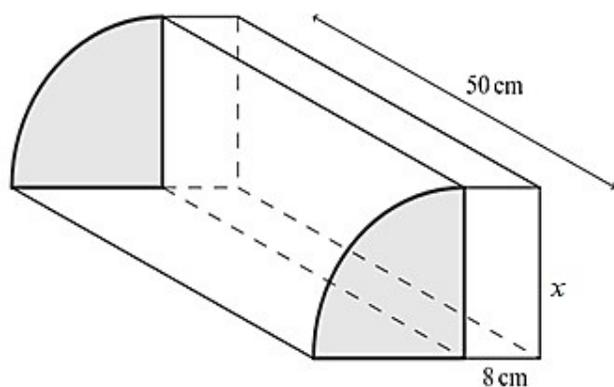
11.1 Calculate the area of the figure using the mid-ordinate rule.

(5)

- 11.2 You have been tasked by your Civil Technology (Woodwork) teacher to make a wooden bread bin with a roller lid, as shown in the picture below.



The cross-sectional diagram is given below with the length of 50 cm, height of  $x$  cm and the breadth of the rectangular section as 8 cm. The bread bin has a quarter of a cylindrical section attached to a rectangular prism.



$$\begin{aligned} \text{Volume of cylinder} &= \pi r^2 h \\ \text{Surface area of cylinder} &= 2\pi r^2 + 2\pi r h \\ \text{Volume rectangular prism} &= l \times w \times h \\ \text{Surface area rectangular prism} &= 2lh + 2lw + 2wh \end{aligned}$$

- 11.2.1 Given that the area of the rectangular section is  $1\,790 \text{ cm}^2$ , calculate the value of  $x$ . (3)

- 11.2.2 Determine the volume of the cylindrical section. (3)

[11]

**TOTAL: 150**

## INFORMATION SHEET

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = -\frac{b}{2a}$$

$$y = \frac{4ac - b^2}{4a}$$

$$a^x = b \Leftrightarrow x = \log_a b, \quad a > 0, a \neq 1 \text{ and } b > 0$$

$$A = P(1 + ni)$$

$$A = P(1 - ni)$$

$$A = P(1 + i)^n$$

$$A = P(1 - i)^n$$

$$i_{\text{eff}} = \left(1 + \frac{i}{m}\right)^m - 1$$

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$$

$$\int kx^n dx = k \cdot \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$$

$$\int \frac{1}{x} dx = \ln(x) + C, \quad x > 0$$

$$\int \frac{k}{x} dx = k \cdot \ln(x) + C, \quad x > 0$$

$$\int a^x dx = \frac{a^x}{\ln a} + C, \quad a > 0$$

$$\int ka^{nx} dx = k \cdot \frac{a^{nx}}{n \ln a} + C, \quad a > 0$$

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$M\left(\frac{x_1 + x_2}{2}; \frac{y_1 + y_2}{2}\right)$$

$$y = mx + c$$

$$y - y_1 = m(x - x_1)$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \tan \theta$$

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

In  $\triangle ABC$ :

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\text{Area} = \frac{1}{2} ab \sin C$$

$$\sin^2 \theta + \cos^2 \theta = 1$$

$$\tan^2 \theta + 1 = \sec^2 \theta$$

$$1 + \cot^2 \theta = \text{cosec}^2 \theta$$

$$\pi \text{ rad} = 180^\circ$$

Angular velocity =  $\omega = 2\pi n$  where  $n$  = rotation frequency

Angular velocity =  $\omega = 360^\circ n$  where  $n$  = rotation frequency

Circumferential velocity =  $v = \pi Dn$  where  $D$  = diameter and  $n$  = rotation frequency

Circumferential velocity =  $v = \omega r$  where  $\omega$  = Angular velocity and  $r$  = radius

Arc length  $s = r\theta$  where  $r$  = radius and  $\theta$  = central angle in radians

Area of a sector =  $\frac{rs}{2}$  where  $r$  = radius and  $s$  = arc length

Area of a sector =  $\frac{r^2\theta}{2}$  where  $r$  = radius and  $\theta$  = central angle in radians

$4h^2 - 4dh + x^2 = 0$  where  $h$  = height of segment,  $d$  = diameter of the circle and  $x$  = length of chord

$A_T = a(m_1 + m_2 + m_3 + \dots + m_{n-1})$  where  $a$  = width of equal parts,  $m_1 = \frac{o_1 + o_2}{2}$   
and  $n$  = number of ordinates

**OR**

$A_T = a\left(\frac{o_1 + o_n}{2} + o_2 + o_3 + o_4 + \dots + o_{n-1}\right)$  where  $a$  = width of equal parts,  $o_i = i^{\text{th}}$  ordinate and  
 $n$  = number of ordinates