



Please paste the barcoded
label here

TOTAL
MARKS

--

NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2022

TECHNICAL MATHEMATICS: PAPER II

EXAMINATION NUMBER

--	--	--	--	--	--	--	--	--	--	--	--	--

Time: 3 hours

150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 28 pages and an Information Sheet of 2 pages (i–ii). Please check that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper and hand this in at the end of the examination. Remember to write your examination number in the space provided.**
4. Diagrams are not necessarily drawn to scale.
5. You may use an approved non-programmable and non-graphical calculator, unless otherwise stated.
6. Round off your answers to two decimal digits where necessary, unless otherwise stated.
7. All the necessary working details must be clearly shown.
8. It is in your own interest to write legibly and to present your work neatly.
9. TWO blank pages (pages 27–28) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the number of your answer should you use this extra space.

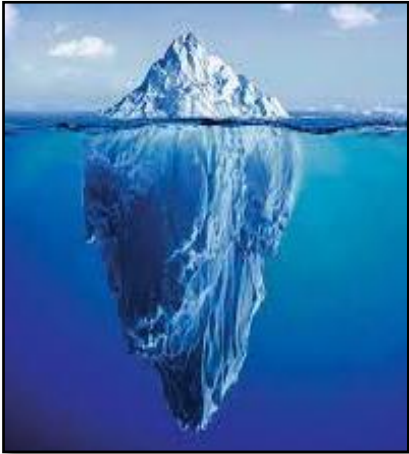
FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	TOTAL
10	16	24	11	14	37	15	19	4	150

QUESTION 1

The picture below shows an iceberg in the vicinity of an Antarctic Research Station. The diagram next to the picture represents the vertical cross-section of the iceberg in the Cartesian Plane. Quadrilateral ABCD with vertices $A(-1 ; 6)$, $B(-8 ; 0)$, $C(-1 ; k)$ and $D(7 ; 0)$ is shown in the diagram with $M(3 ; -8)$ the mid-point of CD.

The angle θ is formed by the x-axis and line AD.



PICTURE

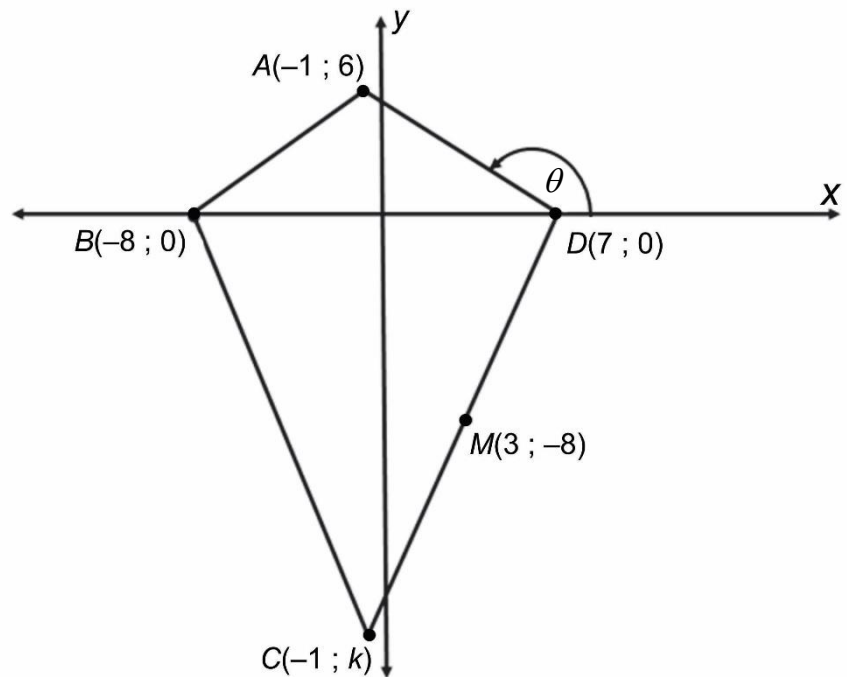


DIAGRAM OF THE VERTICAL CROSS-SECTION

Calculate:

1.1 The gradient of line AD

(2)

1.2 The size of θ (in degrees)

(3)

1.3 The equation of line AD

(2)

1.4 The numerical value of k

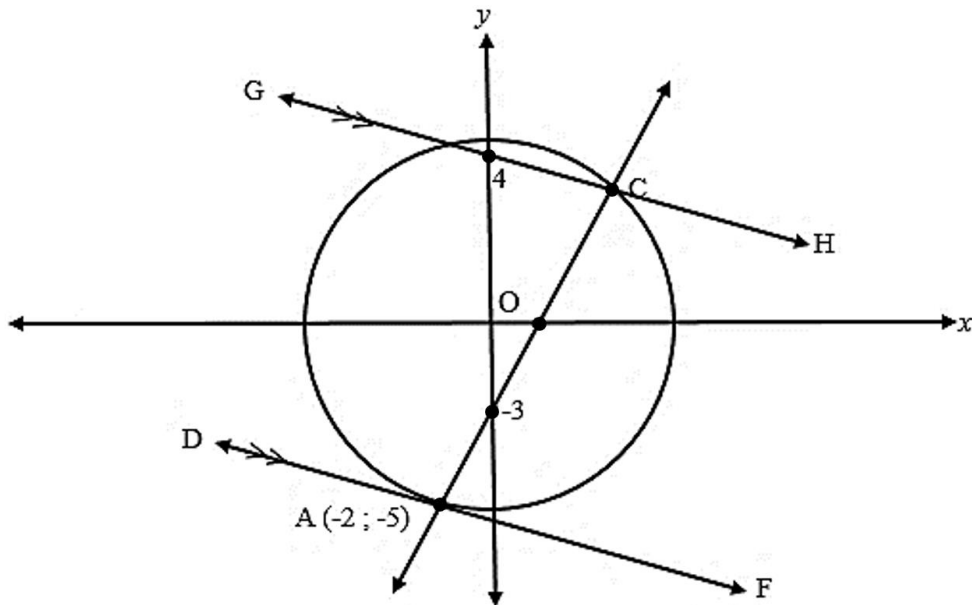
(2)

1.5 Hence, the vertical length AC of the cross section of the iceberg.

(1)
[10]

QUESTION 2

- 2.1 O is the centre of the circle in the diagram below. $A(-2; -5)$ and C are two points on the circle. DF and AC are straight lines intersecting at A. Line DF is a tangent to the circle at A and parallel to line GH. GH and AC are straight lines intersecting at C. The y-intercepts of AC and GH are at $(0; -3)$ and $(0; 4)$ respectively.



- 2.1.1 Determine the equation of the circle.

(2)

- 2.1.2 Determine the equation of line **DF**, the tangent to the circle at A.

(4)

2.1.3 The equation of line AC is $y = x - 3$

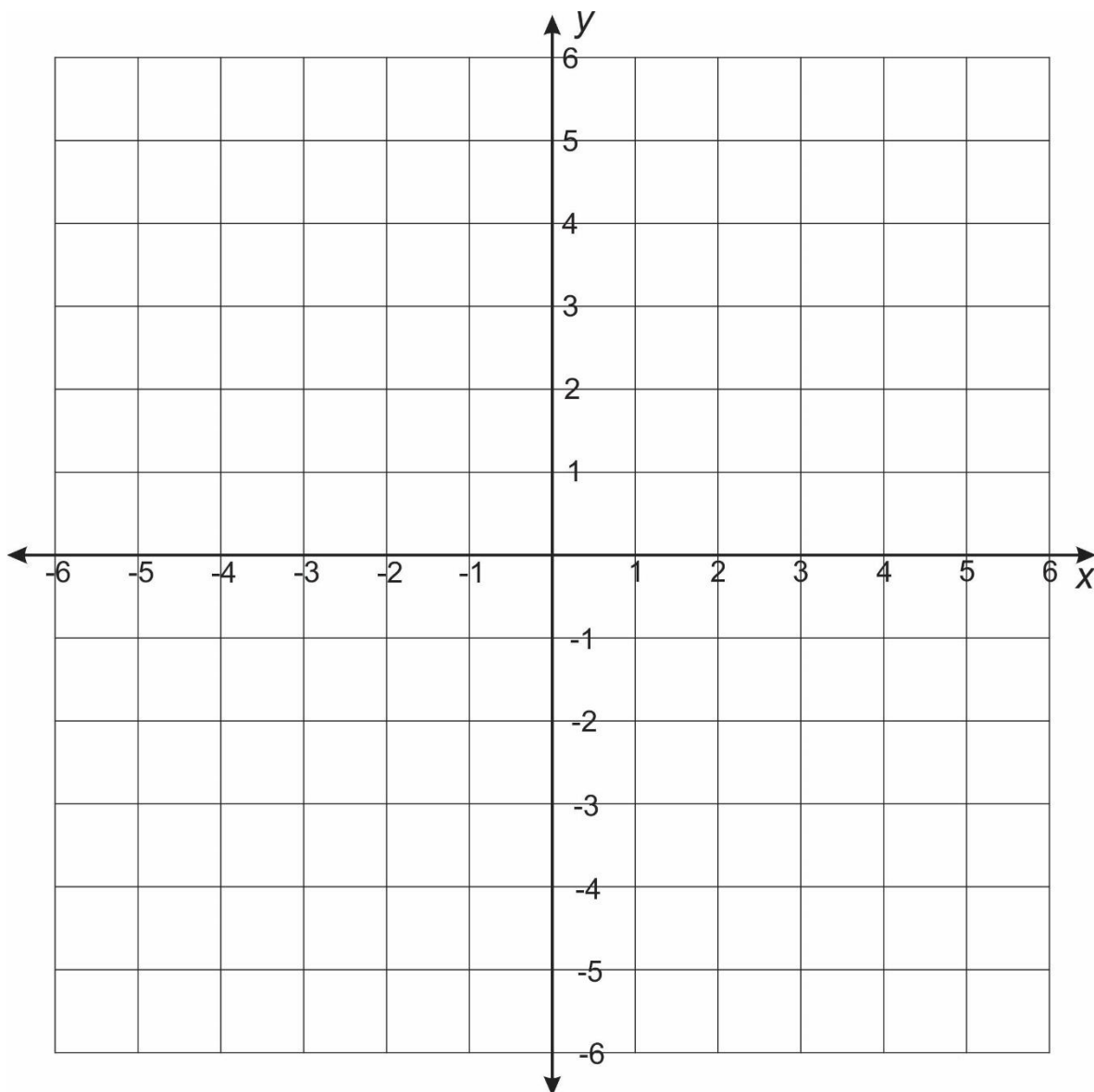
Determine the coordinates of point C. Show ALL calculations.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

(5)

2.2 Sketch the graph defined by $\frac{2x^2}{9} + \frac{2y^2}{25} - 2 = 0$ on the given set of axes below.

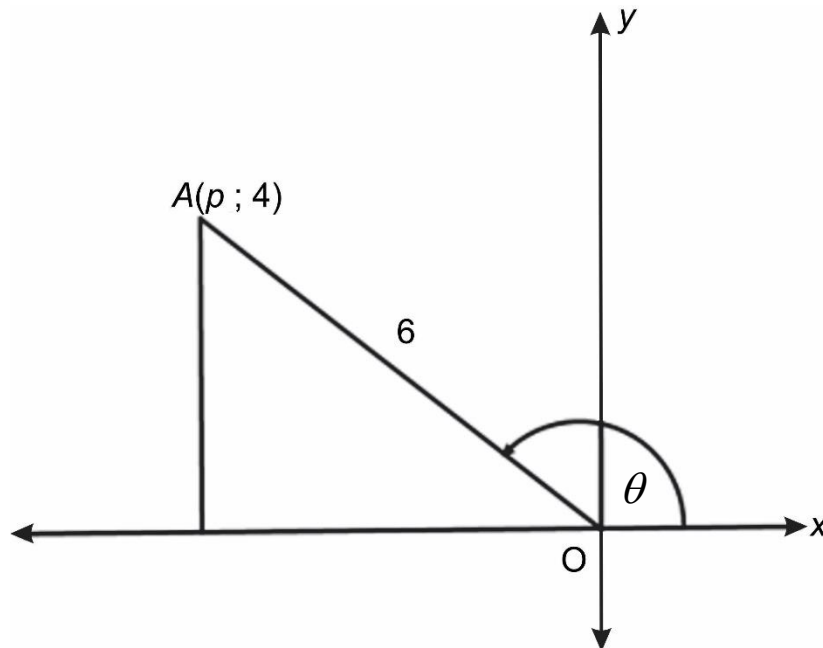
Clearly show ALL the intercepts with the axes.



(5)
[16]

QUESTION 3

- 3.1 In the diagram (not drawn to scale) below, $A(p ; 4)$ is a point in the Cartesian plane. $OA = 6$ and θ is the obtuse angle between the positive x-axis and line OA .



Determine:

- 3.1.1 The numerical value of p (in simplified surd form).

(2)

- 3.1.2 The size of θ (correct to two decimal places).

(3)

- 3.1.3 The numerical value of $\cos^2 \theta - \sin^2 \theta$ (without using a calculator). Show all working.

(4)

3.3 Solve for θ if $\operatorname{cosec} \theta - \sqrt{2} = 0$, $\theta \in [0^\circ; 180^\circ]$

(4)

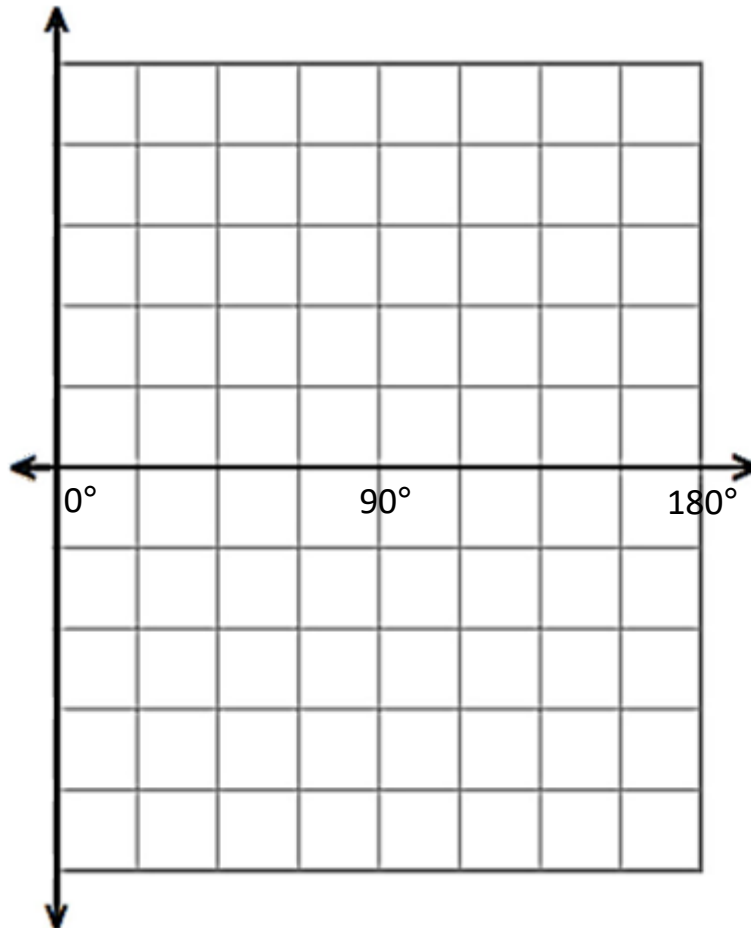
3.4 Prove the identity $\frac{\sin^2 \theta - 1}{\tan \theta \cdot \sin \theta - \tan \theta} = \frac{\sin \theta + 1}{\tan \theta}$.

(3)
[24]

QUESTION 4

Given: $f(x) = \sin \frac{x}{2}$ and $g(x) = 2\cos x$ for $x \in [0^\circ; 180^\circ]$

- 4.1 Sketch the graphs of f and g on the same system of axes provided. Clearly show all intercepts with the axes, turning points and endpoints.



(6)

- 4.2 The x -value where $2\cos x = \sin \frac{x}{2}$ is given as 73° . Write down the values of x for which:

4.2.1 $f(x) \geq g(x)$

(2)

$$4.2.2 \quad g(x) - f(x) = 2$$

(1)

$$4.2.3 \quad g(x + 30^\circ) < 0$$

(2)
[11]

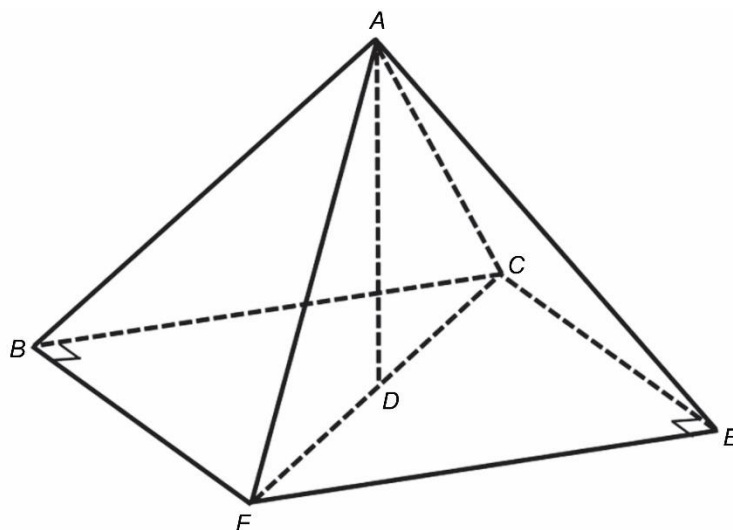
QUESTION 5

Some of the workers in Antarctica lived in right pyramid shaped tents as shown in the picture below.



The diagram below represents the right pyramid shaped tent. BCEF is the square base of the tent with side length 2 m.

$\hat{FAE} = 51,8^\circ$ and $AF = AE$



Calculate the following:

5.1 The length of side AF

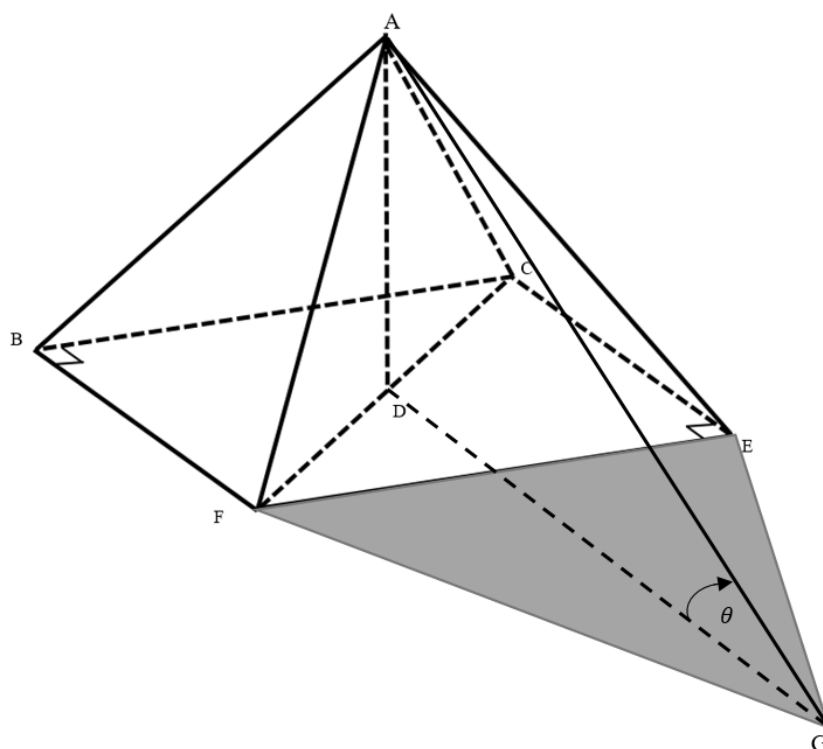
(4)

- 5.2 The **volume** of the tent if the vertical pitch (height) AD directly in the middle of the tent is 1,8 m

$$\text{Volume} = \frac{1}{3} (\text{base area} \times \text{height})$$

(2)

- 5.3 Calculate the area of the shadow $\triangle EFG$ of the tent, which lies in the same horizontal plane as the base of the pyramid, if $FG = EG = 2,3$ m and $\hat{FGE} = 51,5^\circ$.



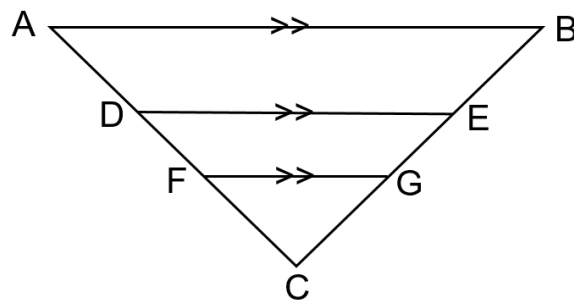
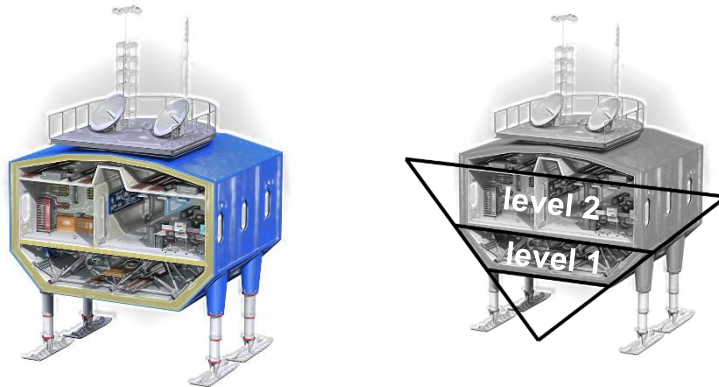
(3)

- 5.4 Calculate θ , the angle of elevation of G, the tip of the shadow, to point A, the tip of the tent.

(5)
[14]

QUESTION 6

- 6.1 The pictures and diagram below shows a vertical cross section of an Antarctic research station. A design principle is illustrated by $\triangle ABC$.



Isosceles $\triangle ABC$ is given with points D and F on line AC and points E and G on line BC . $AC = BC$, $CG = 4$ m, $FG = 6$ m.

$AB \parallel DE \parallel FG$ and $CG : GE : EB = 4 : 3 : 4$

Calculate the following lengths:

6.1.1 EG

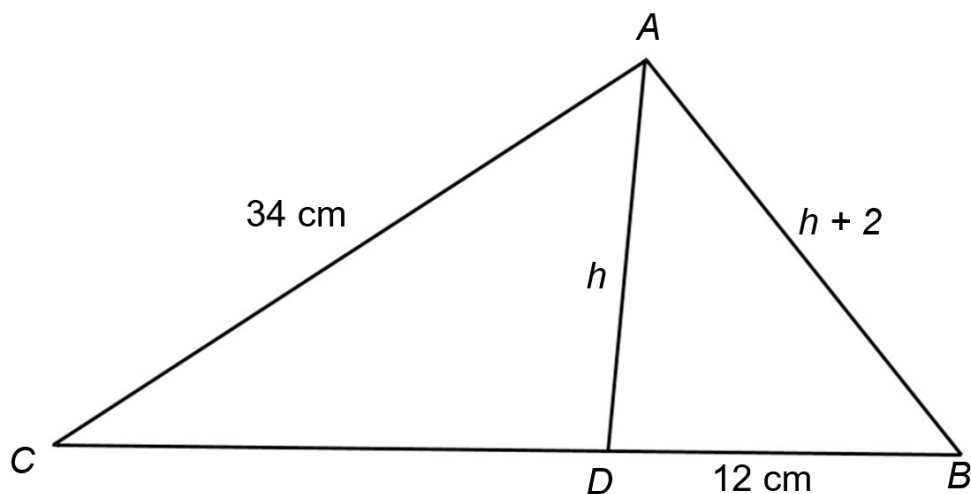
(1)

6.1.2 AB

(3)

6.2 In the diagram below, $\triangle ABC \parallel \triangle DBA$.

$AD = h$ cm, $AB = (h + 2)$ cm, $AC = 34$ cm and $DB = 12$ cm.

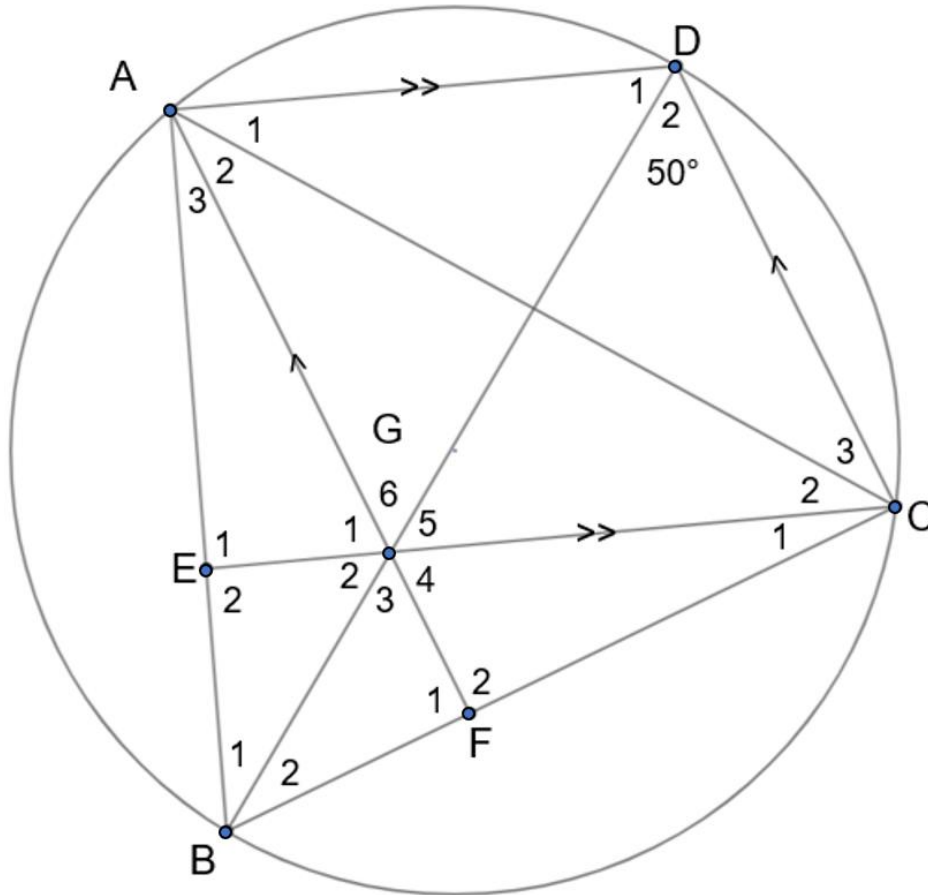


Calculate the numerical value of h .

(5)

- 6.3 In the diagram below AGCD is a parallelogram inside circle ABCD. E and F are points on AB and BC respectively with AF, BD and EC intersecting at G.

$CE \perp AB$ and $\hat{D}_2 = 50^\circ$



6.3.1 Calculate, stating reasons, the size of:

- (a) \hat{DAB}

(2)

- (b) \hat{A}_1

(4)

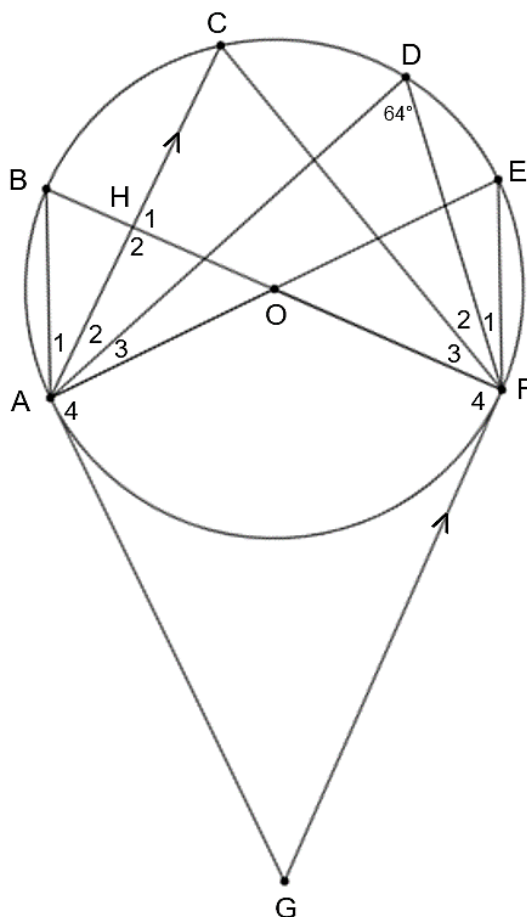
(c) \hat{G}_6

(2)

6.3.2 Prove that ACFE is a cyclic quadrilateral.

(6)

- 6.4 In the diagram below, O is the centre of circle ABCDEF.
 AG and FG are tangents to the circle at A and at F.
 AC || FG
 AE and BF are diameters
 $\hat{D} = 64^\circ$



Calculate, stating reasons, the size of:

6.4.1 \hat{AOF}

(2)

6.4.2 \hat{F}_4

(2)

6.4.3 \hat{F}_3

(4)

6.4.4 Prove that $AOFG$ is a kite.

(4)

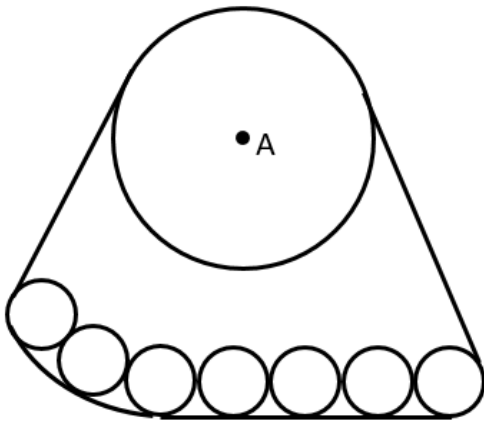
6.4.5 Calculate the size of \hat{G} .

(2)
[37]

QUESTION 7

The picture represents a track system that can be attached to the wheels of standard vehicles to drive on ice.

A simplified diagram below shows a side view of the working of the system.



The radius of circle *A*, representing the primary big wheel, is 22 cm and the radius of each of the smaller circles, representing the small track-wheels, is 5 cm.

The circumferential velocity of the big wheel is 40 km/h.

Calculate:

7.1 The circumferential velocity of the big wheel in m/s

(3)

7.2 The rotational frequency of the big wheel in radians per second

(3)

7.3 The angular velocity of each of the small track wheels in radians per second.

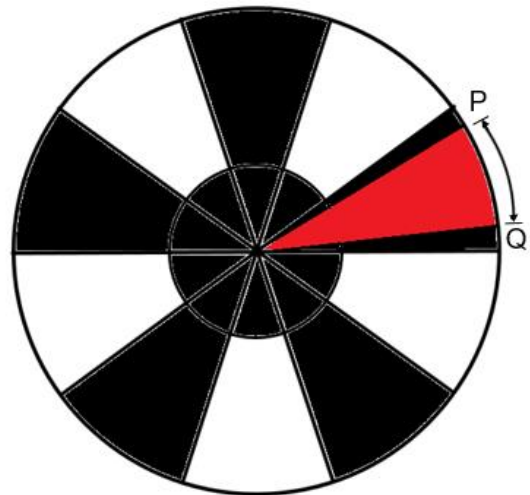
(4)

7.4 Convert the answer obtained in Question 7.3 to degrees per second.

(2)

7.5 A sector of the big wheel must be painted red as indicated on the diagram.

Calculate the red area in cm^2 if the arc length PQ is given as 8,3 cm.

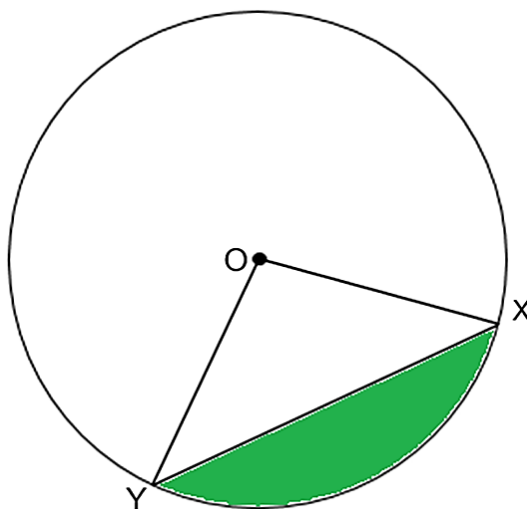


(3)

[15]

QUESTION 8

- 8.1 In the diagram below, O is the centre of the circle with radius 14 cm.
Chord $XY = 21$ cm.



Calculate:

- 8.1.1 The size of \hat{XOY}

(4)

8.1.2 The height of minor segment XY

(4)**8.1.3 The area of minor segment XY**

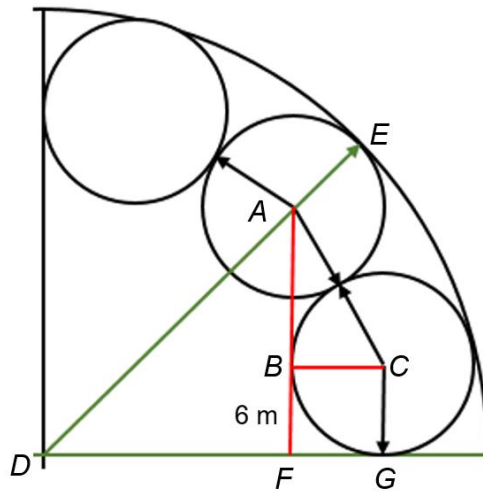
(6)

- 8.2 Three identical smaller circles are placed inside a quarter circle as represented in the diagram. Radius DE of the quarter circle passes through centre A of the middle circle. The length of the radii of the identical circles are 6 m.

C is the centre of the third circle touching the quarter circle at G. The middle circle touches the quarter circle at E.

$ABF \perp DFG$

Calculate the length of the radius of the quarter circle correct to two decimal places.



(5)
[19]

QUESTION 9

The picture below shows an iceberg.

The diagram below represents a vertical cross-section of the submerged part of the iceberg.

The total width AP of the cross-section of the iceberg is 350 m, which is divided into 7 equal parts.

The following vertical (perpendicular) distances were measured:

$$BC = 190 \text{ m}$$

$$DE = 220 \text{ m}$$

$$FG = 290 \text{ m}$$

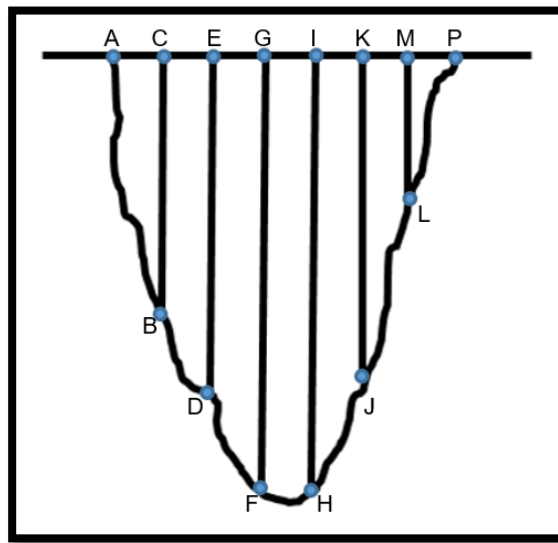
$$HI = 290 \text{ m}$$

$$JK = 210 \text{ m}$$

$$LM = 95 \text{ m}$$



ICEBERG



CROSS-SECTION OF ICEBERG

Calculate the total area of the cross-section by using the given ordinates.

[4]

Total: 150 marks

ADDITIONAL SPACE (ALL QUESTIONS)

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE
ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.**

[illegible]

[illegible]