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CHAPTER NOTES

Area and Perimeter Class 9 Notes | CBSE Maths Chapter 6

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Ira

Your teacher for Area and Perimeter



Hi, I am **Ira**. I teach this syllabus all day, so **Area and Perimeter** is very much my home ground.

Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Area and Perimeter simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Area and Perimeter Class 9 Notes | CBSE Maths Chapter 6

Area and Perimeter is Chapter 6 of CBSE Class 9 Maths. In the new 2026-27 NCERT book, Ganita Manjari (Grade 9, Part I), the chapter is titled "Measuring Space: Perimeter and Area". It starts with a real puzzle, why runners in a 4×100 m relay start at staggered positions, and uses it to build the idea of the perimeter of a circle and the constant π .

The chapter covers perimeter, the C/D ratio and its long history, why π is irrational, arc length, the areas of rectangles, parallelograms and triangles, the median theorem, Heron's formula, Brahmagupta's formula for a cyclic 4-gon, Baudhāyana's squaring of a rectangle, and the area of a circle, a sector and a segment. In the CBSE Class IX course structure for 2026-27, this chapter sits in Unit V, Mensuration, which carries 14 marks together with Surface Area and Volume. The same formulas return in Class 10 in harder problems on circles and triangles.

Quick Answer - Area and Perimeter

Perimeter is the total length around a shape. The area of a sector of a circle with radius r and central angle θ° is $\frac{\theta}{360} \times \pi r^2$. A segment of a circle subtends θ° at the centre has length $2r \sin \frac{\theta}{2}$ and a triangle has area $\frac{1}{2} \times \text{base} \times \text{height}$. Heron's formula gives $\sqrt{s(s-a)(s-b)(s-c)}$. A circle has area πr^2 .



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All Key Formulas at a Glance

Quantity	Formula	Remember
Perimeter of a rectangle	$2(a + b)$	Square: $4a$ (put $b = a$)
The constant π	$\pi = C/D$	$\pi \approx 22/7 \approx 3.14$, and π is irrational
Circumference	$C = \pi d = 2\pi r$	$d = 2r$
Length of an arc	$l = 2\pi r \times \theta/360$	θ in degrees, at the centre
Area of a parallelogram	base $\times$ height = bh	Height is perpendicular to the base
Area of a triangle	$\frac{1}{2} \times \text{base} \times \text{height}$	
Heron's formula	$\sqrt{s(s - a)(s - b)(s - c)}/2$	
Brahmagupta's formula	$\sqrt{(s - a)(s - b)(s - c)(s - d)}/4$	
Area of a trapezium	$\frac{1}{2}(a + b)h$	
Area of a circle	$A = \pi r^2$	
Area of a sector	$\pi r^2 \times \theta/360$	



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Key Concepts

1. Perimeter and the C/D Ratio (the

The **perimeter** of a shape is the total length walking once around the border, never turn

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distance it walks is the perimeter.

Shape	Perimeter	Ratio perimeter : side
Square of side a	4a	4 : 1 for every square
Equilateral triangle of side a	3a	3 : 1 for every equilateral triangle
Rectangle a by b	2(a + b)	Depends on the shape of the rectangle

The square formula is a **special case** of the rectangle formula: put $b = a$ in $2(a + b)$ and you get $4a$.

Double the side of a square from 2 units to 4 units and the perimeter doubles from 8 units to 16 units. The ratio of perimeter to side stays fixed at 4 : 1 whatever the size. The same idea works for circles. The perimeter of a circle is called its **circumference** (C). The diameter is D. The ratio is fixed 3.14 times that **$C \div D$, the circumference divided by the diameter** is a constant. For a bicycle wheel or a giant wheel. The textbook calls this the **constant of proportionality**.

$\pi = C/D$, so **$C = \pi D = 2\pi r$** , because the diameter is twice the radius.

Home measurement from the textbook. V wrap a string round a circular object. Measure it several times. Unwrap it and measure its length L. Divide by the diameter D. This method estimates the C/D ratio. You should get a result close to π .

2. The Journey of π and Why π Is Irrational

The chapter traces how mathematicians in ancient times found π . It lists the main approximations and who found them. It shows how the value of π has been refined over time.



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Who and when	Value or method
Mesopotamia (c. 1900 BCE)	A circle is slightly longer than the hexagon inside it, so $\pi > 3$. They used $3 + 1/8 = 3.125$
Archimedes (by 250 BCE)	Trapped π between inscribed and circumscribed polygons. Hexagons gave $3 < \pi < 2\sqrt{3} \approx 3.46$. With 96-sided polygons: $3 \frac{10}{71} < \pi < 3 \frac{1}{7}$
Ptolemy (c. 150 CE)	$377/120 \approx 3.14167$
Liu Hui (263 CE), Zu Chongzhi (480 CE)	Circle-cutting with up to 24,576 sides. Zu gave $22/7 \approx 3.1428$ (Yuelü) and $355/113 \approx 3.1415929$ (Miü), the best value in the world for over 800 years
Āryabhaṭa (499 CE)	$62832/20000 = 3.1416$, called <i>asanna</i> , meaning "approaching" or approximating
Brahmagupta (628 CE)	$\sqrt{10} \approx 3.162$
Mādhava of Sangamagrāma	First exact series. He gave 3.14159265



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In 1706 William Jones used the Greek letter π to make the symbol popular.

π is irrational. A rational number can be written as a fraction of two integers. Its decimal expansion ends or repeats in a pattern. π is 3.142857.... The digits of π go on forever without repeating. π is not the ratio of two integers. Lambert proved this in 1761. He regarded π as irrational long before.

Since π is irrational, there is no "best fraction" that is closer. So we write $\pi \approx 22/7$ and also $\pi \approx 3.14$.

3. Length of an Arc and the Area of a Sector

A diameter AB splits a circle into two semi-circles (each 180° about the centre O) and the two semi-circles are equal in area.

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length $2\pi r \div 2 = \pi r$. Rotating through 90° shows the four quarter circles are equal, so each is $2\pi r \div 4 = \pi r/2$.

Written as a share of the full turn: semicircle = $2\pi r \times 180/360$ and quarter circle = $2\pi r \times 90/360$. So an arc AB that subtends an angle θ° at the centre has

length of arc = $2\pi r \times \theta/360$

A **sector** is the region bounded by an arc and the two radii to its ends. Its perimeter is the arc plus two radii: **perimeter of sector = $2\pi r \times \theta/360 + 2r$** .

The 400 m track. A standard track has two straight sections of 84.39 m each and two semicircular ends with a common centre. The innermost semicircle has radius 36.5 m, and each lane is 1.22 m wide. An athlete runs 0.3 m from the inner border of lane 1:

- Straights: $2 \times 84.39 = 168.78$ m.
- The two semicircles of radius $36.5 + 0.3 = 36.8$ m.
 $2 \times \pi \times 36.8 = 231.22$ m.
- Total: $168.78 + 231.22 = 400$ m.

On the straights, all lanes run the same distance. On the semicircular ends, the athlete runs on a semicircle of larger radius, so she covers more distance. The difference in the starting points of adjacent lanes, makes up for this. The problem is often asked as a question. A simple estimate assumes the athlete runs on the inner edge of her own lane. Then the runner on the outer lane runs the two semicircles (one full circle) the extra distance. The runner on the inner lane starts about 7.67 m ahead. Under this assumption, the difference in radius, so each pair of neighbouring lanes measure the outer lanes slightly differently.

4. Areas of Rectangles, Parallelograms and Triangles

Area is the amount of space a flat region takes up. It is measured in square units (unit² (1 sq. unit)). A rectangle with sides a and b has area ab .

Parallelogram. Cut a right triangle off one end. The pieces form a rectangle with the same area. The area of a parallelogram = **base $\times$ height = bh** . When a parallelogram does not land on the opposite side, the text says that the area of parallelograms of the same base and height is the same.



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Side lengths are not enough for a parallelogram. Keep the four sides fixed and change the angle between them: the height changes, so the area changes. A rhombus of side 3 can have area 9 (a square), 8.01 or 5.41, depending on how much it is pushed over.

Triangle. Two congruent copies of a triangle fit together to make a parallelogram with the same base and height. So

$$\text{area of triangle} = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2}bh$$

Enclosing the triangle in a rectangle gives the same result: the triangle fills half the rectangle.

Median theorem. A **median** joins a vertex to the midpoint of the opposite side. In $\triangle ABC$, let AD be a median with $BD = DC = a$, and let h be the height from A to BC. Triangles ABD and ACD have equal bases a and the same height h , so each has area $ah/2$.

Theorem: A median of a triangle divides it into two triangles with equal area. The two triangles are usually different in shape (not congruent).

Other shapes built from these:

- **Trapezium** with parallel sides a and b and height h : area = $\frac{1}{2}(a+b)h$
- **Kite** (and rhombus): area = $\frac{1}{2} \times d_1 \times d_2$

5. Heron's Formula and Other Triangles

Heron of Alexandria gave a way to find the area of a triangle without knowing the height. For $\triangle ABC$ with $BC = a$, $CA = b$, $AB = c$,

$$\text{semi-perimeter } s = (a + b + c)/2$$

$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$

The textbook tests the formula against $\frac{1}{2} \times \text{base} \times \text{height}$.



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Triangle	Heron's formula gives	Check with $\frac{1}{2}bh$
Equilateral, side a	$s = 3a/2$, each $(s - a) = a/2$, area $= \sqrt{(3a^4/16)} = (\sqrt{3}/4)a^2$	$h = (\sqrt{3}/2)a$, $\frac{1}{2} \times a \times$ $(\sqrt{3}/2)a = (\sqrt{3}/4)a^2$
Isosceles, equal sides a , base $2b$	$s = a + b$, area $= \sqrt{[(a + b)(b)(b)(a - b)]} = b\sqrt{(a^2 - b^2)}$	$h = \sqrt{(a^2 - b^2)}$, $\frac{1}{2} \times 2b \times h$ $= b\sqrt{(a^2 - b^2)}$
Sides 3, 4, 5	$s = 6$, area $= \sqrt{(6 \times 3 \times 2 \times 1)} = 6$	$3^2 + 4^2 = 5^2$, so right- angled: $\frac{1}{2} \times 3 \times 4 = 6$

The height of an equilateral triangle comes from the Baudhāyana-Pythagoras theorem: $h^2 = a^2 - (a/2)^2 = 3a^2/4$, $\therefore h = (\sqrt{3}/2)a$. One proof of Heron's formula uses this theorem and the identity $a^2 - b^2 = (a - b)(a + b)$; it comes in Grade 10.

Two circle formulas for area. Every triangle has a **circumcircle** (one passing through all three vertices, radius R) and one **incircle** (one touching all three sides, radius r).

- Area of $\triangle ABC = abc/(4R)$
- Area of $\triangle ABC = r(a + b + c)/2 = rs$

6. Brahmagupta's Formula, Special Cases

Can we find the area of a 4-gon (quadrilateral) if we know its four sides? Brahmagupta (c. 628 CE) showed three different areas for a cyclic quadrilateral, one using a diagonal, or a geometric property. One such formula is Brahmagupta's formula.

Brahmagupta's formula (628 CE). For a cyclic quadrilateral with sides a, b, c, d :

$$\text{Area} = \sqrt{[(s - a)(s - b)(s - c)(s - d)]}$$

- **Rectangle** (all rectangles are cyclic), sides a, b : $s = (a + b)/2$, $\text{Area} = ab$. Correct.
- **Isosceles trapezium** (all isosceles trapezia are cyclic), sides a, b, c, c : $s = a + b + c$, and the formula simplifies to $\sqrt{[c^2 - (b - a)^2]}$, so this is $(a + b)h$, which is the area.



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Heron is a special case of Brahmagupta. Treat a triangle with sides a, b, c as a 4-gon whose fourth side $d = 0$ (two vertices coincide). Every triangle is cyclic, since a circle passes through any three points not on a line. With $d = 0$, $s = (a + b + c)/2$ and $s - d = s$, so Brahmagupta's formula becomes $\sqrt{[s(s - a)(s - b)(s - c)]}$, which is Heron's formula. We say Brahmagupta's formula **generalises** Heron's formula.

Special case and generalisation. A special case comes from a general result by adding an extra condition. Examples from the chapter:

- A square is a special case of a rectangle: $A = ab$ with $b = a$ gives $A = a^2$.
- An isosceles right triangle is a special case of a right triangle: $a^2 + b^2 = c^2$ with $a = b$ gives $c = a\sqrt{2}$.
- $(a + b)^2 = a^2 + b^2 + 2ab$ is $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$ with $c = 0$.

Squaring a rectangle (Baudhāyana, Śulbasūtra, 800 BCE). To “square” a shape means to construct a square with the same area. For rectangle ABCD with $AD = a$, $AB = b$ and $a \geq b$:

1. Mark E on AD with $AE = AB = b$.
2. Mark F, the midpoint of ED.
3. Draw square AFGH with side AF, with H on AD.
4. With centre H, draw arc AG. Let it cut side BC at K.
5. Through K draw a line parallel to AH, cutting BC at L.
6. Square HPQS on side HP has the same area as rectangle ABCD.

Why it works. $AF = (AE + AD)/2 = (a + b)/2$. In right triangle ABF , $AB^2 + BF^2 = AF^2$. So $b^2 + [(a - b)/2]^2 = [(a + b)/2]^2$. Simplifying, $b^2 + (a^2 - 2ab + b^2)/4 = (a^2 + 2ab + b^2)/4$. Multiplying both sides by 4, $4b^2 + a^2 - 2ab + b^2 = a^2 + 2ab + b^2$. Subtracting $a^2 + b^2$ from both sides, $4b^2 - 2ab = 2ab$. Dividing both sides by 2, $2b^2 - ab = ab$. Adding ab to both sides, $2b^2 = 2ab$. Dividing both sides by 2, $b^2 = ab$. Taking the square root of both sides, $b = \sqrt{ab}$. $\square$

7. Area of a Circle, Sector and Seg

Why area grows with the square of the si
every equilateral triangle, $P^2 : A = (3a)^2 : ($
shape, not its size. So for circles too, $C^2 :$

- The Babylonians (well before 1500 BCE)
- The Egyptians (around 1500 BCE) used the Baudhāyana Śulbasūtra.

A screenshot of a chat application. At the top, there is a dark blue header bar. On the left of this bar is a circular profile picture of a woman with dark hair, smiling. To the right of the profile picture, the name 'Ira' is written in white, bold font. Below the name, the text 'Your teacher for Area and Perimeter' is written in a smaller white font. The main area of the chat is white. On the left side of this area, there is a smaller circular profile picture of the same woman. To the right of this picture, there is a text bubble with a light blue border. Inside the bubble, the text reads: 'Hi, I am Ira. I teach this syllabus all day, so Area and Perimeter is very much my home ground. Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:'. At the bottom of the screen, there is a white bar with the text 'Free questions, no login needed' in a medium-sized black font. Below this bar, there is a line of smaller text: 'AI generated, can make mistakes. Cross-check with NCERT.'

- Archimedes (c. 250 BCE) proved the constant A/r^2 is exactly π : **$A = \pi r^2$** .

Archimedes put it this way: the area of a circle equals the area of a right triangle whose two shorter sides are the radius and the circumference. So $A = \frac{1}{2} \times 2\pi r \times r = \pi r^2$.

Nilakanṭha's slices (c. 1500). Cut a circle into many thin slices like a pizza and lay them alternately point-up and point-down. As the slices get thinner, the shape becomes almost a parallelogram with base = half the circumference = πr and height = r . Area = $\pi r \times r = \pi r^2$.

Sector. By reflection symmetry a semicircular disc is $180/360 = \frac{1}{2}$ of the circle, $\frac{1}{2}\pi r^2$. By quarter-turn symmetry a quadrant is $90/360 = \frac{1}{4}$ of the circle, $\frac{1}{4}\pi r^2$. In general, a sector whose arc subtends θ° at the centre has

area of sector = $\pi r^2 \times \theta/360$

Segment. A **segment** is the region bounded by an arc and the chord joining its ends. The minor segment is the part of the sector left after removing the triangle formed by the two radii:

area of minor segment = area of sector –

area of major segment = area of circle –

Two triangles come up again and again. For $\theta = 60^\circ$, $OA = OB$ and the angle between them is 60° . The area of the triangle is $(\sqrt{3}/4)r^2$.

8. How Length and Area Change with Scale

If every length in a figure is multiplied by k , the area is multiplied by k^2 .

- A rectangle with sides $2a$ and $2b$ has an area four times that of a rectangle with sides a and b . Four copies really do fit inside it.
- A triangle with sides $2a$, $2b$, $2c$ has 4 times the area of a triangle with sides a , b , c . If the sides are $3a$, $3b$, $3c$ it has 9 times the area.
- For circles, $C = 2\pi r$ is proportional to r . If the radii are in the ratio $5 : 4$, and the areas are $25 : 16$.



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Formula and Theorem Sheet

Result	Formula or statement	Notes
Perimeter of square, triangle, rectangle	$4a, 3a$ (equilateral), $2(a + b)$	Square is the case $b = a$
Definition of π	$\pi = C/D$	Same for all circles; irrational
Circumference	$C = \pi d = 2\pi r$	Semicircle arc πr , quarter arc $\pi r/2$
Arc length	$l = 2\pi r \times \theta/360$	θ = angle at centre in degrees
Parallelogram	base $\times$ height	
Triangle	$\frac{1}{2} \times \text{base} \times \text{height}$	
Median theorem	A median divides a triangle into two triangles of equal area	
Heron's formula	$\sqrt{s(s-a)(s-b)(s-c)}$ where $s = (a+b+c)/2$	
Brahmagupta's formula	$\sqrt{(s-a)(s-b)(s-c)(s-d)}$ where $s = (a+b+c+d)/2$	
Trapezium	$\frac{1}{2}(a+b)h$	
Kite, rhombus	$\frac{1}{2}d_1d_2$	
Squaring a rectangle	$[(a+b)/2]^2 - [(a-b)/2]^2$	
Circle	$A = \pi r^2$	
Sector	$\pi r^2 \times \theta/360$	



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Result	Formula or statement	Notes
Segment	Sector – triangle OAB	Major = circle – minor

Important Definitions

- **Perimeter:** the total length around the border of a shape.
- **π (pi):** the constant ratio of the circumference of a circle to its diameter, the same for all circles. $\pi \approx 22/7 \approx 3.14$.
- **Irrational number:** a number that cannot be written as a ratio of two integers. π and $\sqrt{2}$ are irrational.
- **Stagger:** the distance between the starting points of adjacent lanes on a running track.
- **Arc:** a part of a circle between two points.
- **Sector:** the region bounded by an arc and two radii.
- **Segment:** the region bounded by an arc and a chord.
- **Median of a triangle:** the line segment joining a vertex to the midpoint of the opposite side.
- **Circumcircle:** the one circle that passes through all the vertices of a polygon.
- **Incircle:** the one circle that fits tightly inside a polygon.
- **Cyclic 4-gon:** a 4-gon (quadrilateral) whose vertices lie on a single circle. Isosceles trapezoids are cyclic.
- **Squaring a shape:** constructing a square with the same area as a given shape.



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Solved Examples (NCERT)

Use $\pi = 22/7$ unless another value is stated.

Example 1 (Exercise Set 6.1, Q1). The perimeter of a circular sector is 44 cm. Find the radius of the circle.

Solution: $2\pi r = 44 \Rightarrow 2 \times (22/7) \times r = 44 \Rightarrow r = 7$ cm.

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Example 2 (Exercise Set 6.1, Q2). Calculate, correct to 3 significant figures, the circumference of a circle with: (i) radius 7 cm (ii) radius 10 cm (iii) radius 12 cm.

Solution:

- (i) $C = 2 \times (22/7) \times 7 = 44 \text{ cm} = 44.0 \text{ cm}$.
- (ii) $C = 2 \times (22/7) \times 10 = 440/7 = 62.857... \approx 62.9 \text{ cm}$.
- (iii) $C = 2 \times (22/7) \times 12 = 528/7 = 75.428... \approx 75.4 \text{ cm}$.

Example 3 (Exercise Set 6.1, Q3). Calculate the length of the arc of a circle if: (i) the radius is 3.5 cm and the angle at the centre is 60° , and (ii) the radius is 6.3 m and the angle at the centre is 120° .

Solution:

- (i) Full circumference $= 2 \times (22/7) \times 3.5 = 22 \text{ cm}$. Arc $= 22 \times 60/360 = 22/6 = 11/3 \approx 3.67 \text{ cm}$.
- (ii) Full circumference $= 2 \times (22/7) \times 6.3 = 46.2 \text{ m}$. Arc $= 46.2 \times 120/360 = 15.4 \text{ m}$.

Example 4 (Exercise Set 6.1, Q4). Find the perimeter of a sector (as the two straight portions) of a circle of radius 14 cm if the angle at the centre is 120° .

Solution: Circumference $= 2 \times (22/7) \times 14 = 88 \text{ cm}$.
Arc length $= 88 \times 120/360 = 29.33 \text{ cm}$.
Perimeter $= \text{arc} + 2r = 18.33 + 28 = 46.33 \text{ cm}$.

Example 5 (Textbook Example 1). Two circles of equal radii are drawn with centres A and B and meet at C and D. Find the perimeter of the region bounded by the two arcs (the outer boundary only).

Solution: $AB = AC = BC = r$, so $\triangle ABC$ is equilateral. $\angle CAD = 120^\circ$. The arc CD of circle A that lies inside the region is $1/3$ of that circle. The outer part of each circle is $2/3$ of the circle.
Perimeter $= 2 \times (2/3) \times 2\pi r = 8\pi r/3$ units.

Example 6 (Textbook Example 2). Points P, Q, R, S, T, U are marked on a line segment PQ such that the segments PQ, QR, RS, ST, TU, UP are in the ratio 1:2:3:4:5:6. Find the length of the segment PQ.

Solution: Let the radii be a', b', c', d' . A series of circles are drawn with centres at P, Q, R, S, T, U. The length of the segment PQ is $2a' = 2b' + 2c' + 2d'$. Since $PQ = 2a' = 2b' + 2c' + 2d'$, the length of the segment PQ is $2a'$.



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Example 7 (Exercise Set 6.2, Q3). Find the area of a triangle, given that its sides are 8 cm and 11 cm long, and its perimeter is 32 cm.

Solution: Third side = $32 - 8 - 11 = 13$ cm. $s = 32/2 = 16$ cm. $s - a = 8$, $s - b = 5$, $s - c = 3$.

$$\text{Area} = \sqrt{(16 \times 8 \times 5 \times 3)} = \sqrt{1920} = \sqrt{(64 \times 30)} = 8\sqrt{30} \approx 8 \times 5.477 \approx 43.8 \text{ cm}^2.$$

Example 8 (Exercise Set 6.2, Q2). The parallel sides of a trapezium are 40 cm and 20 cm. If its non-parallel sides are both equal, each being 26 cm, find the area of the trapezium.

Solution: Drop perpendiculars from the ends of the 20 cm side to the 40 cm side. They cut off two equal pieces of $(40 - 20)/2 = 10$ cm. Each slant side is the hypotenuse of a right triangle with base 10 cm, so height $h = \sqrt{(26^2 - 10^2)} = \sqrt{(676 - 100)} = \sqrt{576} = 24$ cm.

$$\text{Area} = \frac{1}{2}(40 + 20) \times 24 = 30 \times 24 = \mathbf{720 \text{ cm}^2}.$$

Check with Brahmagupta (an isosceles tra
= $\sqrt{[(56 - 40)(56 - 20)(56 - 26)(56 - 26)]}$

Example 9 (End-of-Chapter, Q6). The side
the area of the triangle in two different wa

Solution: *Method 1:* $7^2 + 24^2 = 49 + 576 =$
cm and 24 cm. Area = $\frac{1}{2} \times 7 \times 24 = 84$ cm

Method 2 (Heron): $s = (7 + 24 + 25)/2 = 2$

Example 10 (Exercise Set 6.3, Q1). Find th
angle of the sector is 60° .

Solution: Area of circle = $(22/7) \times 49 = 15$
 cm^2 .

Example 11 (Exercise Set 6.3, Q5). A chon
at the centre of the circle. Find the areas c
circle. (Use $\pi \approx 3.14$ and $\sqrt{3} \approx 1.73$.)

Solution:

- Area of sector = $3.14 \times 225 \times 60/360 =$



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- $OA = OB = 15 \text{ cm}$ and $\angle AOB = 60^\circ$, so $\triangle OAB$ is equilateral. Area = $(\sqrt{3}/4) \times 225 = 1.73 \times 225/4 = 97.3125 \text{ cm}^2$.
- Minor segment = $117.75 - 97.3125 = 20.4375 \approx 20.44 \text{ cm}^2$.
- Area of circle = $3.14 \times 225 = 706.5 \text{ cm}^2$. Major segment = $706.5 - 20.4375 = 686.0625 \approx 686.06 \text{ cm}^2$.

Example 12 (Exercise Set 6.3, Q6). A car has two wipers which do not overlap. Each wiper has a blade of length 28 cm and sweeps through an angle of 120° . Find the total area cleaned at each sweep of the blades.

Solution: Each wiper sweeps a sector of radius 28 cm and angle 120° . Area = $(22/7) \times 28 \times 28 \times 120/360 = 2464 \times 1/3 = 2464/3 \text{ cm}^2$. Two wipers: $2 \times 2464/3 = 4928/3 \approx \mathbf{1642.67 \text{ cm}^2}$.

Competency-Based Questions (with answers)

Q1. Case study: the athletics track. A 400 m track has two straight sections and two semicircular ends with a common radius of 36.5 m and each lane is 1.22 m wide. An athlete in lane 1 runs one lap. Find the distance she runs. (Use $\pi = 3.1416$.)

- (i) What is the radius of the path she runs?
- (ii) Find the distance she runs on the two straight sections.
- (iii) Show that one lap is 400 m.
- (iv) Why does a runner in lane 2 start at a different point?

Answer: (i) $36.5 + 0.3 = 36.8 \text{ m}$. (ii) The two straight sections are 84.39 m long. The total distance on the two straight sections is $2 \times 84.39 = 168.78 \text{ m}$. (iii) The two semicircular ends have a common radius of 36.5 m. The perimeter of a semicircle is πr . The total distance on the two semicircular ends is $2 \times \pi \times 36.5 = 2 \times 3.1416 \times 36.5 = 231.22 \text{ m}$. (iv) The runner in lane 2 follows a semicircle of larger radius, so she starts at a different point so that both runners cover the same total distance.

Q2. Assertion-reason. Assertion (A): The area of a triangle is half the product of its base and height. Reason (R): If the base of a triangle is doubled, the area is also doubled. (A) is true, (R) is false.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.



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Answer: (a). Area = base $\times$ height, and the height depends on the angle. A rhombus of side 3 can have area 9, 8.01 or 5.41.

Q3. Assertion-reason. Assertion (A): $\pi = 22/7$. Reason (R): π is an irrational number.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (d). $22/7$ is a fraction of two integers, so it is rational. π is irrational, so $\pi \neq 22/7$. We only write $\pi \approx 22/7$.

Q4. Assertion-reason. Assertion (A): A median of a triangle divides it into two triangles of equal area. Reason (R): The two triangles formed by a median are always congruent.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (c). The two triangles have equal area. They are usually different in shape, so R is false.

Q5. Assertion-reason. Assertion (A): Heron's formula. Reason (R): Every triangle is cyclic with side $d = 0$.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (a). Putting $d = 0$ makes $s - d = s$. The formula becomes $\frac{1}{4}s[s - a][s - b][s - c]$.

Q6. Source-based: the story of π . Read: "The value of π is approximately 3.1416. The fraction $22/7$ is a good approximation of π . The fraction $355/113$ is a very good approximation of π . The fraction $62832/20000 = 3.1416$ for π . Crucially, he used the word 'approximate'."

- (i) Why is the word *asanna* important?
- (ii) Which approximation stayed the most popular? Why did you find it?



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- (iii) Which mathematician gave the first exact formula for π , and what is it?

Answer: (i) It shows Āryabhaṭa understood that 3.1416 is only close to π and that π cannot be written exactly as one simple fraction, which fits π being irrational. (ii) 355/113, found by Zu Chongzhi. (iii) Mādhava of Sangamagrāma: $\pi/4 = 1 - 1/3 + 1/5 - 1/7 + \dots$

Q7. Case study: the clock. The minute hand of a wall clock is 7 cm long.

- (i) Through what angle does the minute hand turn in 10 minutes?
- (ii) Find the area swept by the minute hand in 10 minutes.
- (iii) How far does the tip of the hand travel in the same time?

Answer: (i) 60 minutes = 360° , so 10 minutes = 60° . (ii) Sector area = $(22/7) \times 49 \times 60/360 = 154/6 = 77/3 \approx 25.67 \text{ cm}^2$. (iii) Arc = $2 \times (22/7) \times 7 \times 60/360 = 44/6 = 22/3 \approx 7.33 \text{ cm}$.

Q8. Case study: the garden plot. A triangular garden has sides in the ratio 3 : 5 : 7 and a perimeter of 300 m. A gardener wants to

- (i) Find the three sides.
- (ii) Find the semi-perimeter.
- (iii) Find the area of grass needed.

Answer: (i) Sum of ratio parts = 15, so one = 150 m. (iii) Area = $\sqrt{(150 \times 90 \times 50 \times 10)}$



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Important Questions for

The grouping below is a practice ladder for stated.

1-Mark Questions

Q1. Define π in terms of a circle.

Answer: π is the ratio of the circumference

Q2. Is π equal to 22/7? Give a reason.

Answer: No. 22/7 is rational and π is irrational.

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Q3. Find the semi-perimeter of a triangle with sides 7 cm, 8 cm and 9 cm.

Answer: $s = (7 + 8 + 9)/2 = 12$ cm.

Q4. Find the area of a quadrant of a circle of radius 14 cm.

Answer: $\frac{1}{4} \times (22/7) \times 196 = 154$ cm².

2-Mark Questions

Q5 (Exercise Set 6.1, Q8). The ratio of the perimeters of two circles is 5:4. What is the ratio of their radii?

Answer: $2\pi r_1 : 2\pi r_2 = 5 : 4$. Cancel 2π : $r_1 : r_2 = 5 : 4$.

Q6 (Exercise Set 6.2, Q5). One diagonal of a rhombus is twice as long as the other diagonal. If the rhombus has area 128 cm², find the length of the shorter diagonal.

Answer: Let the diagonals be d and $2d$. Area = $\frac{1}{2} \times d \times 2d = d^2 = 128$, so $d = \sqrt{128} = 8\sqrt{2} \approx 11.31$ cm.

Q7 (End-of-Chapter, Q3). An isosceles triangle has equal sides of length 10 cm each. Find the length of the equal sides?

Answer: $\frac{1}{2} \times 10 \times h = 60$, so $h = 12$ cm. Then $h = \sqrt{(10^2 - 5^2)} = \sqrt{169} = 13$ cm.

Q8 (End-of-Chapter, Q4). The area of a right-angled triangle is 54 cm². One of the legs is 12 cm. Find its perimeter.

Answer: $\frac{1}{2} \times 12 \times x = 54$, so the other leg is 9 cm. Perimeter = $12 + 9 + 15 = 36$ cm.

3-Mark Questions

Q9 (End-of-Chapter, Q2). An isosceles triangle has equal sides of length 10 cm each. Find the area of the triangle.

Answer: Base = $40 - 30 = 10$ cm. $s = 20$. Area = $\frac{1}{2} \times 10 \times 10 = 50$ cm².
 $\times 5 \times 5 \times 10) = \sqrt{5000} = 50\sqrt{2} \approx 70.71$ cm².
 $10\sqrt{2} = 50\sqrt{2}$.

Q10 (End-of-Chapter, Q5). The sides of a square are in the ratio 3:4:5. Find its area.

Answer: One part = $45/9 = 5$, so the sides are 15, 20, 25. Area = $\sqrt{(22.5 \times 12.5 \times 7.5 \times 2.5)}$.



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Q11 (Exercise Set 6.3, Q4). A chord of a circle of radius 10 cm subtends 90° at the centre. Find the area of the corresponding: (i) minor sector (that subtends 90° at the centre), and (ii) major sector (that subtends 270° at the centre). (Use $\pi \approx 3.14$.)

Answer: Circle = $3.14 \times 100 = 314 \text{ cm}^2$. (i) Minor sector = $314 \times 90/360 = 78.5 \text{ cm}^2$. (ii) Major sector = $314 \times 270/360 = 235.5 \text{ cm}^2$.

Q12 (End-of-Chapter, Q9). The wheel of a car has an outer radius of 28 cm. Calculate how far the car travels after one complete turn of the wheel, and how many times the wheel turns during a journey of 1 km.

Answer: One turn = $2 \times (22/7) \times 28 = 176 \text{ cm}$. 1 km = 100000 cm. Number of turns = $100000/176 \approx 568.2$, so the wheel makes about **568 complete turns**.

5-Mark Questions

Q13 (Exercise Set 6.2, Q9). In $\triangle ABC$, the midpoint of BC is D. Median AD is drawn. P is any point on AD. Show that area ($\triangle ABP$) = area ($\triangle ACP$).

Answer: AD is a median of $\triangle ABC$, so by the property of medians, area($\triangle ABD$) = area($\triangle ACD$). (1). In $\triangle PBC$, PD joins P to the midpoint D of BC, so area($\triangle PBD$) = area($\triangle PCD$) ... (2). Subtract (2) from (1): area($\triangle ABP$) = area($\triangle ACP$). Since P lies on AD, $\triangle ABD$ is made of $\triangle ABP$ and $\triangle PBD$, and $\triangle ACD$ is made of $\triangle ACP$ and $\triangle PCD$. Therefore, area($\triangle ABP$) = area($\triangle ACP$).

Q14 (Exercise Set 6.3, Q8). An equilateral triangle has side length 12 cm. Find the ratio of the area of the triangle to the area of the circle inscribed in it.

Answer: *Triangle:* join the centre O to the vertices. Each of the three triangles has two sides r and angle 120° at O. The area of each is $\frac{1}{2} \times r \times r \times \sin 120^\circ = \frac{\sqrt{3}}{4} r^2$. The angle at O is split into two 60° angles. The side of the triangle is $\sqrt{3} r$. Area of triangle = $\frac{\sqrt{3}}{4} (\sqrt{3} r)^2 = \frac{3\sqrt{3}}{4} r^2$. So the side is $\sqrt{3} r$. Area of circle = πr^2 . Ratio = $\frac{3\sqrt{3}/4}{\pi} \approx 5.196/12.566 \approx 0.413$.

Q15 (End-of-Chapter, Q24). Semicircles are drawn on the sides of a right-angled triangle. Show that Area (A) + Area (B) = Area (C), where A and B are the areas of the semicircles on the shorter sides and C is the area of the semicircle on the hypotenuse.

Answer: Let the legs be a, b and the hypotenuse be c. Area of semicircle on a is $\frac{1}{2} \pi (a/2)^2 = \pi a^2/8$. Area of semicircle on b is $\pi b^2/8$. Area of semicircle on c is $\pi c^2/8$. By the Baudhāyana-Pythagoras theorem $a^2 + b^2 = c^2$. Therefore, Area(A) + Area(B) = Area(C).

Q16 (End-of-Chapter, Q23). Two concentric circles have radii R and r. A chord of the larger circle touches the smaller circle at A. Find the area of the region between the two circles is $\frac{1}{4} \pi (R^2 - r^2)$.

Answer: Let the radii be R (larger) and r (smaller). The chord of the larger circle touches the smaller circle at A, so it is perpendicular to the radius OA. The area of the region between the two circles is the area of the larger circle minus the area of the smaller circle, which is $\pi R^2 - \pi r^2 = \pi (R^2 - r^2)$. Since the chord is perpendicular to OA, it bisects OA. The area of the region between the two circles is $\frac{1}{4} \pi (R^2 - r^2)$.



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every other point of BC lies outside the smaller circle and is further than r from O. So OA is the shortest distance from O to BC, which means $OA \perp BC$. In right triangles OAB and OAC, the hypotenuses $OB = OC = R$ and the side OA is common, so the triangles are congruent (RHS) and $AB = AC = l/2$. (This is the circle fact that the perpendicular from the centre to a chord bisects the chord.) In right triangle OAB, $R^2 = r^2 + (l/2)^2$, so $R^2 - r^2 = l^2/4$. Area between the circles $= \pi R^2 - \pi r^2 = \pi(R^2 - r^2) = \frac{1}{4}\pi l^2$.

Common Mistakes and Examiner Tips

- Using the diameter in $C = 2\pi r$.** If the question gives the diameter, halve it first or use $C = \pi d$. A 56 cm tyre has circumference $(22/7) \times 56 = 176$ cm, not 352 cm.
- Writing $\pi = 22/7$.** π is irrational. Write $\pi \approx 22/7$ or "taking $\pi = 22/7$ ". In a true/false or assertion question, " $\pi = 22/7$ " is false.
- Forgetting the two radii in a sector's perimeter.** The perimeter of a sector is the sum of the two radii and the arc length alone is the arc length.
- Mixing arc length and sector area.** Arc length is in units (cm), while sector area is in units cm^2 . Check the unit of your answer.
- Using the slant side as the height.** In a sector, the perpendicular distance between the two radii is the height, not the slant side. Use the Pythagorean theorem when only the slant side is given.
- Using the perimeter for s in Heron's formula.** In Heron's formula, s is the semi-perimeter, so $s - a$, $s - b$, and $s - c$ are all positive and add up to the perimeter.
- Applying Brahmagupta's formula to a general 4-gon.** Brahmagupta's formula only applies to cyclic quadrilaterals. For a general 4-gon, the four sides do not fix the area.
- Segment = sector.** A segment is the area of a circle cut off by a chord. A sector is the area of a circle cut off by two radii. Calculate the area of a segment as a separate step.
- Wrong triangle in a segment problem.** In a segment, the triangle formed by the two radii and the chord is the triangle to consider. If the angle is 90° it is right-angled, area $\frac{1}{2}r^2$. Do not use the area of the sector.
- Unit conversion in wheel problems.** Convert the circumference to metres before dividing by π to find the radius.
- Assuming a median gives congruent triangles.** A median divides a triangle into two triangles of equal area, not necessarily congruent. They are congruent only if the median is also an altitude (in an isosceles triangle) or a perpendicular bisector.



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Quick Revision Points

- Square $4a$, equilateral triangle $3a$, rectangle $2(a + b)$.
- For every circle, C/D is the same constant, π .
- $C = \pi d = 2\pi r$. Semicircle arc $= \pi r$, quarter arc $= \pi r/2$.
- Arc length $= 2\pi r \times \theta/360$. Sector perimeter $= \text{arc} + 2r$.
- Mesopotamia 3.125 ; Archimedes $3 \frac{10}{71} < \pi < 3 \frac{1}{7}$; Ptolemy $377/120$; Zu Chongzhi $22/7$ and $355/113$; Āryabhaṭa 3.1416 ; Brahmagupta $\sqrt{10}$.
- Mādhava: $\pi/4 = 1 - 1/3 + 1/5 - 1/7 + \dots$, the first exact formula.
- π is irrational (Lambert, 1761); $\pi \approx 22/7 \approx 3.14$, $\pi \neq 22/7$.
- Rectangle ab ; parallelogram base $\times$ height; triangle $\frac{1}{2} \times \text{base} \times \text{height}$.
- Sides alone do not fix the area of a parallelogram or a general 4-gon.
- A median divides a triangle into two triangles of equal area.
- Heron: $s = (a + b + c)/2$, area $= \sqrt{s(s-a)(s-b)(s-c)}$.
- Brahmagupta (cyclic 4-gon): $\sqrt{(s-a)(s-b)(s-c)(s-d)}$.
- Trapezium $\frac{1}{2}(a + b)h$; kite and rhombus $a^2 \sin \theta$.
- Baudhāyana squared a rectangle using a triangle.
- Babylonians $A \approx C^2/12$; Egyptians $A \approx (\frac{1}{2}C)^2$.
- $A = \frac{1}{2} \times \text{circumference} \times \text{radius} = \pi r^2$; $A = \frac{1}{2} \pi r^2$ and height r .
- Sector area $= \pi r^2 \times \theta/360$; semicircle $\frac{1}{2} \pi r^2$.
- Minor segment $= \text{sector} - \text{triangle}$; major segment $= \text{sector} + \text{triangle}$.
- Scale lengths by k : perimeters $\times k$, area $\times k^2$.



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Weightage and Exam Pattern

Class 9 has no board exam. This chapter is in the yearly exam and the annual exam. In the CBSE 2020-21, **Unit V, Mensuration, carries 14 marks** in 10 chapters, Area and Perimeter and Surface Area and Volume. The unit is allotted 27 teaching periods. Assessment: pen-paper tests and multiple assessment (10), portfolio (5) and lab practical (5).

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The course structure expects students to compute circumference, arc length and the areas of circles, sectors and segments, use Heron's formula, explain the median theorem and the squaring of a shape, list historical approximations to π , and explain why Heron's formula is a special case of Brahmagupta's. The 1, 2, 3 and 5-mark grouping above is a practice ladder; the exact question types in a given school paper are set by that paper.

The CBSE Class IX question paper design weights questions by thinking skill: about 54% remembering and understanding, 24% applying, and 22% analysing, evaluating and creating.

This chapter is the foundation for Class 10, where arc length, sector and segment areas and triangle areas return in harder problems.



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