

# CLASS 9 MATHEMATICS – CHAPTER 6

## NOTES

### Measuring Space: Perimeter and Area

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Chapter 6 is “**Measuring Space: Perimeter and Area.**” The new textbook develops perimeter and area through **visualisation, decomposition, transformation and derivation of formulas**, rather than simply asking students to memorise formulas.

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## CHAPTER 6: MEASURING SPACE – PERIMETER AND AREA

### Learning Objectives

By the end of this chapter, you should be able to:

-  Understand perimeter and area
  -  Find the perimeter of different plane figures
  -  Derive area formulas using visual methods
  -  Find the area of triangles and quadrilaterals
  -  Use Heron's formula for a triangle
  -  Find the area of a regular polygon
  -  Find the area of composite figures
  -  Find the area of a circle and parts of a circle
  -  Solve real-life problems involving perimeter and area
  -  Understand how changing dimensions affects area and perimeter
- 

### CHAPTER AT A GLANCE

6.1  Perimeter and Area

6.2  Area of a Triangle

6.3  Area of Quadrilaterals

6.4  Area of Regular Polygons

6.5  Area of Composite Figures

6.6  Area of a Circle

6.7  Areas of Parts of a Circle

6.8  Applications in Real Life

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## 1. WHAT IS PERIMETER?

The **perimeter** of a closed plane figure is the total distance around its boundary.

 **In simple words:**

**Perimeter = distance around a figure**

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### Example

A rectangle has:

Length = 8 cm

Breadth = 5 cm

Its perimeter is:

$$8 + 5 + 8 + 5$$

$$= 26 \text{ cm}$$

Therefore:

★ **Perimeter = 26 cm**

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## 2. WHAT IS AREA?

The **area** of a plane figure is the amount of surface enclosed by its boundary.

 **In simple words:**

**Area = space covered by a figure**

Area is measured in **square units**.

Examples:

$\text{cm}^2$

$\text{m}^2$

$\text{km}^2$

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## 3. PERIMETER VS AREA

| Perimeter               | Area                                         |
|-------------------------|----------------------------------------------|
| Boundary length         | Surface covered                              |
| Measured in units       | Measured in square units                     |
| cm, m, km               | $\text{cm}^2$ , $\text{m}^2$ , $\text{km}^2$ |
| One-dimensional measure | Two-dimensional measure                      |

**Example:**

For a square of side 5 cm:

Perimeter:

$$4 \times 5 = 20 \text{ cm}$$

Area:

$$5 \times 5 = 25 \text{ cm}^2$$

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## 4. AREA OF A RECTANGLE

For a rectangle:

$$\text{Area} = \text{length} \times \text{breadth}$$

or:

$$A = l \times b$$

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### Example

$$l = 12 \text{ cm}$$

$$b = 7 \text{ cm}$$

Therefore:

$$A = 12 \times 7$$

$$A = 84 \text{ cm}^2$$

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## 5. PERIMETER OF A RECTANGLE

$$P = 2(l + b)$$

Example:

$$l = 12 \text{ cm}$$

$$b = 7 \text{ cm}$$

$$P = 2(12 + 7)$$

$$= 2 \times 19$$

$$P = 38 \text{ cm}$$

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## 6. AREA OF A SQUARE

If the side of a square is  $a$ :

$$\text{Area} = a^2$$

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### Example

$$\text{Side} = 9 \text{ cm}$$

$$\text{Area} = 9^2$$

$$= 81 \text{ cm}^2$$

---

## 7. PERIMETER OF A SQUARE

$$P = 4a$$

For side  $9 \text{ cm}$ :

$$P = 4 \times 9$$

$$= 36 \text{ cm}$$

---

## 8. AREA OF A TRIANGLE

The area of a triangle is:

$$\text{Area} = 1/2 \times \text{base} \times \text{height}$$

or:

$$A = \frac{1}{2}bh$$

where:

$b$  = base

$h$  = perpendicular height

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## 9. EXAMPLE

Base = 10 cm

Height = 8 cm

Therefore:

$$A = \frac{1}{2} \times 10 \times 8$$

$$= 5 \times 8$$

$$= 40 \text{ cm}^2$$

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## 10. WHY IS THE TRIANGLE FORMULA $\frac{1}{2}bh$ ?

Take two identical triangles.

When placed together appropriately, they can form a parallelogram.

Area of parallelogram:

$$\text{base} \times \text{height}$$

The two triangles are equal.

Therefore area of one triangle:

$$\frac{1}{2} \times \text{base} \times \text{height}$$

So:

$$\star A = \frac{1}{2}bh$$

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## 11. AREA OF A TRIANGLE USING HERON'S FORMULA

When all three sides of a triangle are known, Heron's formula can be used.

Suppose sides are:

$$a, b, c$$

First calculate the semi-perimeter:

$$s = (a + b + c) / 2$$

Then:

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

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## 12. HERON'S FORMULA – EXAMPLE

Consider a triangle with sides:

3 cm, 4 cm, 5 cm

First:

$$s = (3 + 4 + 5)/2$$

$$= 12/2$$

$$s = 6 \text{ cm}$$

Now:

$$\text{Area} = \sqrt{[6(6-3)(6-4)(6-5)]}$$

$$= \sqrt{(6 \times 3 \times 2 \times 1)}$$

$$= \sqrt{36}$$

$$= 6 \text{ cm}^2$$

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## 13. WHEN TO USE HERON'S FORMULA?

Use Heron's formula when:



All three sides are known

and



The perpendicular height is not directly available.

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## 14. AREA OF A PARALLELOGRAM

Formula:

$$\text{Area} = \text{base} \times \text{height}$$

or:

$$A = bh$$

⚠ The height must be the **perpendicular height**, not necessarily the slant side.

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## Example

Base = 15 cm

Height = 8 cm

$$A = 15 \times 8$$

$$= 120 \text{ cm}^2$$

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## 15. AREA OF A RHOMBUS

A rhombus has two diagonals.

If the diagonals are:

$d_1$  and  $d_2$

then:

$$\text{Area} = \frac{1}{2}d_1 d_2$$

---

## Example

$$d_1 = 12 \text{ cm}$$

$$d_2 = 8 \text{ cm}$$

$$A = \frac{1}{2} \times 12 \times 8$$

$$= 48 \text{ cm}^2$$

---



## 16. AREA OF A KITE

For a kite with diagonals  $d_1$  and  $d_2$ :

$$\text{Area} = \frac{1}{2}d_1 d_2$$

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## 17. AREA OF A TRAPEZIUM

If the parallel sides are:

$a$  and  $b$

and perpendicular height is  $h$ :

$$\text{Area} = \frac{1}{2}(a+b)h$$

---

## Example

Parallel sides:

8 cm and 12 cm

Height:

5 cm

Therefore:

$$A = \frac{1}{2}(8+12) \times 5$$

$$= \frac{1}{2} \times 20 \times 5$$

$$= 50 \text{ cm}^2$$

---



## 18. WHY DOES THE TRAPEZIUM FORMULA WORK?

Two identical trapeziums can be rearranged to form a parallelogram.

The base of the resulting parallelogram is:

$$a + b$$

and its height is:

$$h$$

Therefore:

$$\text{Area of two trapeziums} = (a+b)h$$

Hence:

$$\text{Area of one trapezium} = \frac{1}{2}(a+b)h$$

---



## 19. AREA OF A QUADRILATERAL BY DIVIDING IT INTO TRIANGLES

A quadrilateral can be divided into two triangles using a diagonal.

Therefore:

## Area of quadrilateral

= Area of triangle 1 + Area of triangle 2

This is a very useful method for irregular quadrilaterals.

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## 20. AREA OF A REGULAR POLYGON

A **regular polygon** has:

- ✓ Equal sides
- ✓ Equal angles

Examples:

- ▲ Equilateral triangle
  - Square
  - ⬡ Regular hexagon
- 



## 21. AREA OF A REGULAR POLYGON

A regular polygon can be divided into equal triangles by joining its centre to its vertices.

Therefore:

$$\text{Area} = \frac{1}{2} \times \text{perimeter} \times \text{apothem}$$

where the **apothem** is the perpendicular distance from the centre to a side.

So:

$$A = \frac{1}{2}Pa$$

where:

P = perimeter

$a$  = apothem

---



## 22. EXAMPLE – REGULAR HEXAGON

Suppose:

Perimeter = 36 cm

Apothem = 5 cm

Then:

$$\text{Area} = \frac{1}{2} \times 36 \times 5$$

$$= 18 \times 5$$

$$= 90 \text{ cm}^2$$

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## 23. COMPOSITE FIGURES

A **composite figure** is made up of two or more simple shapes.

For example:

 Rectangle +  Triangle

or:

 Square –  Circle

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## 24. HOW TO FIND AREA OF A COMPOSITE FIGURE

Step **1**

Break the figure into familiar shapes.

### Step 2

Find the area of each part.

### Step 3

Add the areas if the parts are joined.

### Step 4

Subtract areas if a portion has been removed.

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## 25. EXAMPLE

A figure consists of a rectangle and a triangle.

Rectangle:

$$l = 10 \text{ cm}$$

$$b = 6 \text{ cm}$$

Area:

$$60 \text{ cm}^2$$

Triangle:

$$b = 10 \text{ cm}$$

$$h = 4 \text{ cm}$$

Area:

$$\frac{1}{2} \times 10 \times 4 = 20 \text{ cm}^2$$

Total:

$$60 + 20$$

$$= 80 \text{ cm}^2$$

---

## 26. CIRCLE

A circle has:

**Radius =  $r$**

**Diameter =  $2r$**

The circumference of a circle is:

$$C = 2\pi r$$

or:

$$C = \pi d$$

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## 27. AREA OF A CIRCLE

The area of a circle is:

$$A = \pi r^2$$

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### Example

Radius =  $7 \text{ cm}$

Using:

$$\pi = 22/7$$

$$A = 22/7 \times 7 \times 7$$

$$= 22 \times 7$$

$$= 154 \text{ cm}^2$$

---

## 28. WHY IS THE AREA OF A CIRCLE $\pi r^2$ ?

Imagine dividing a circle into many thin sectors.

Arrange these sectors alternately.

As the number of sectors increases, they form a shape increasingly close to a rectangle.

Its:

**Height  $\approx r$**

and:

**Base  $\approx \pi r$**

Therefore:

$$\text{Area} \approx \pi r \times r$$

$$= \pi r^2$$

This provides a visual way to understand the circle-area formula.

---

## 29. CIRCUMFERENCE VS AREA

| Quantity | Formula |
|----------|---------|
|----------|---------|

|               |           |
|---------------|-----------|
| Radius        | $r$       |
| Diameter      | $2r$      |
| Circumference | $2\pi r$  |
| Area          | $\pi r^2$ |

 **Remember:**

**Circumference** → one  $r$

**Area** →  $r^2$

---

## 30. PARTS OF A CIRCLE

The chapter also studies regions formed from parts of circles.

Important examples include:

### ♦ **Semicircle**

Half of a circle.

### ♦ **Quadrant**

One-fourth of a circle.

### ♦ **Sector**

Region enclosed by two radii and an arc.

### ♦ **Segment**

Region enclosed by a chord and its corresponding arc.

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## 31. AREA OF A SEMICIRCLE

A semicircle is half a circle.

Therefore:

$$\text{Area} = \frac{1}{2}\pi r^2$$

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## Example

Radius = 14 cm

$$\text{Area} = \frac{1}{2} \times \frac{22}{7} \times 14 \times 14$$

$$= 22 \times 14$$

$$= 308 \text{ cm}^2$$

---



## 32. AREA OF A QUADRANT

A quadrant is:

$\frac{1}{4}$  of a circle.

Therefore:

$$\text{Area} = \frac{1}{4}\pi r^2$$

---



## 33. AREA OF A SECTOR

If a sector has central angle  $\theta$ :

$$\text{Area of sector} = \frac{\theta}{360^\circ} \times \pi r^2$$

---

## Example

Radius = 6 cm

Angle =  $60^\circ$

Then:

$$\text{Area} = 60/360 \times \pi \times 6^2$$

$$= 1/6 \times 36\pi$$

$$= 6\pi \text{ cm}^2$$

---



## 34. ARC LENGTH

For a sector with central angle  $\theta$ :

$$\text{Arc length} = \theta/360^\circ \times 2\pi r$$

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## Example

$$r = 7 \text{ cm}$$

$$\theta = 90^\circ$$

Arc length:

$$= 90/360 \times 2\pi \times 7$$

$$= \frac{1}{4} \times 14\pi$$

$$= 7\pi/2 \text{ cm}$$

Using  $\pi = 22/7$ :

$$= 11 \text{ cm}$$

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## 35. AREA OF A SEGMENT

A segment is the region between:

 An arc

and

 Its corresponding chord.

To find its area:

**Area of segment = Area of sector - Area of triangle**

This is especially useful when the sector and triangle are known.

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## 36. COMPOSITE CIRCULAR FIGURES

Sometimes a figure contains:

 Circle +  Rectangle

or:

 Square -  Circle

For such questions:

**Area required**

= Area of larger shape - Area of removed shape

or:

= Sum of individual areas

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## 37. REAL-LIFE APPLICATIONS

Perimeter and area are used in:

-  Designing houses
  -  Planning gardens
  -  Building roads
  -  Measuring fields
  -  Flooring rooms
  -  Painting walls
  -  Designing sports grounds
  -  Planning walking tracks
- 



## 38. EXAMPLE – GARDEN

A rectangular garden has:

Length = 20 m

Breadth = 15 m

### Area

$$= 20 \times 15$$

$$= 300 \text{ m}^2$$

### Perimeter

$$= 2(20 + 15)$$

$$= 70 \text{ m}$$

If fencing costs ₹50 per metre:

Total cost:

$$= 70 \times 50$$

$$= ₹3500$$

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## 39. PERIMETER AND AREA CAN CHANGE DIFFERENTLY

Suppose the side of a square changes.

If:

side = 5 cm

Area:

25 cm<sup>2</sup>

Perimeter:

20 cm

If side becomes:

10 cm

Area:

100 cm<sup>2</sup>

Perimeter:

40 cm

Notice:



Side doubled.



Perimeter doubled.



Area became **four times**.

This is an important mathematical relationship.

---



## 40. SCALING RULE

If every length of a figure is multiplied by  $k$ :

**Perimeter becomes:**

$$k \times \text{original perimeter}$$

**Area becomes:**

$$k^2 \times \text{original area}$$

---

## Example

If every dimension is doubled:

$$k = 2$$

Perimeter:

$$2 \times \text{original}$$

Area:

$$2^2 = 4 \times \text{original}$$

★ **Area becomes four times.**

---



## 41. FORMULA SHEET



### Square

**Perimeter**

$$P = 4a$$

**Area**

$$A = a^2$$

---

## Rectangle

### Perimeter

$$P = 2(l+b)$$

### Area

$$A = lb$$

---

## Triangle

### Area

$$A = \frac{1}{2}bh$$

---

## Parallelogram

### Area

$$A = bh$$

---

## Trapezium

### Area

$$A = \frac{1}{2}(a+b)h$$

---

## Rhombus

## Area

$$A = \frac{1}{2}d_1d_2$$

---

## Circle

### Circumference

$$C = 2\pi r$$

### Area

$$A = \pi r^2$$

---

## Semicircle

### Area

$$A = \frac{1}{2}\pi r^2$$

---

## Quadrant

### Area

$$A = \frac{1}{4}\pi r^2$$

---

## Sector

### Area

$$A = \frac{\theta}{360^\circ} \times \pi r^2$$

### Arc length

$$= \theta/360^\circ \times 2\pi r$$

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## ▲ Heron's Formula

### Semi-perimeter

$$s = (a+b+c)/2$$

### Area

$$\sqrt{[s(s-a)(s-b)(s-c)]}$$

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## 42. IMPORTANT TERMS

| Term             | Meaning                                              |
|------------------|------------------------------------------------------|
| Perimeter        | Distance around a figure                             |
| Area             | Surface enclosed by a figure                         |
| Radius           | Centre to circle                                     |
| Diameter         | Chord through centre                                 |
| Chord            | Segment joining two points on circle                 |
| Arc              | Part of circumference                                |
| Sector           | Region between two radii and an arc                  |
| Segment          | Region between chord and arc                         |
| Apothem          | Perpendicular from centre to side of regular polygon |
| Composite figure | Figure made of multiple simple figures               |

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## 43. COMMON MISTAKES

### ✗ Mistake 1

Writing area in centimetres.

✓ **Area must be in:**

$\text{cm}^2$

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### ✗ Mistake 2

Using diameter instead of radius in:

$\pi r^2$

If diameter is given:

$r = d/2$

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### ✗ Mistake 3

Using slant height instead of perpendicular height in triangle/parallelogram area.

✓ **Use the perpendicular height.**

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### ✗ Mistake 4

Forgetting the  $\frac{1}{2}$  in triangle area.

**Area =  $\frac{1}{2} \times \text{base} \times \text{height}$**

---

### ✗ Mistake 5

Using  $\pi r$  as circle area.

✗  $\pi r$

✓  $\pi r^2$

---

### ✗ Mistake 6

Forgetting that sector area depends on the central angle.

$$\text{Sector Area} = \theta/360^\circ \times \pi r^2$$

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## 44. EXAM-IMPORTANT QUESTIONS

You should be able to solve:

### ♦ Basic

1. Find the area of a rectangle.
2. Find the perimeter of a square.
3. Find the area of a triangle.
4. Find the circumference of a circle.

### ♦ Application

5. Find the cost of fencing a rectangular field.
6. Find the area of a path surrounding a garden.
7. Find the area of a composite figure.
8. Find the amount of material needed to cover a circular region.

### ♦ Reasoning

9. Why does doubling the side of a square make its area four times?
10. Why is the area of a triangle half the area of a parallelogram with the same base and height?

### ♦ Higher-order

11. Find the area of an irregular figure by dividing it into simpler figures.
12. Find the area of a triangle using Heron's formula.
13. Find the area of a sector.

14. Find the area of a circular segment.

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## 45. PROBLEM-SOLVING STRATEGY

When you see an area/perimeter question:

### STEP 1

Draw the figure.

### STEP 2

Write all given dimensions.

### STEP 3

Identify the shape.

### STEP 4

Choose the appropriate formula.

### STEP 5

Substitute values carefully.

### STEP 6

Check the units.

### STEP 7

For a composite figure, add or subtract the required areas.

---

## 46. QUICK REVISION

 Perimeter

## Distance around

### Rectangle

$$A = lb$$

### Square

$$A = a^2$$

### Triangle

$$A = \frac{1}{2}bh$$

### Parallelogram

$$A = bh$$

### Trapezium

$$A = \frac{1}{2}(a+b)h$$

### Rhombus

$$A = \frac{1}{2}d_1d_2$$

### Circle

$$A = \pi r^2$$

### Circumference

$$C = 2\pi r$$

### Semicircle

$$A = \frac{1}{2}\pi r^2$$

### Quadrant

$$A = \frac{1}{4}\pi r^2$$

### Sector

$$A = \frac{\theta}{360^\circ} \times \pi r^2$$

### ▲ Heron's Formula

$$s = (a+b+c)/2$$

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

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## ★ 47. CHAPTER TAKEAWAY

The key idea of Chapter 6 is **not simply memorising formulas**. The new textbook encourages you to understand where formulas come from by **cutting, rearranging, decomposing and visualising shapes**.



Shape



Decompose / Rearrange



Understand the relationship



Derive the formula



Apply it to real-life problems

So, whenever you see a complicated figure, don't panic! 😊

**Break it into familiar shapes** → **find individual areas** → **add/subtract** → **get the required area.**   