6 Perimeter and Area

Why This Chapter Matters

Have you ever wondered how much ribbon is needed to wrap a gift box? Or how many tiles are needed to cover your kitchen floor? These questions are all about measuring shapes. One measure, **perimeter**, tells us the distance around a shape, like a fence around a garden. The other, **area**, tells us the space inside a shape, like the grass inside the garden. In this chapter, we'll become measurement detectives, uncovering the secrets of perimeter and area to solve real-world puzzles!

Meet EeeBee.AI

Hello, explorers! I'm EeeBee, your friendly math robot. I love measuring things! How long is the longest pencil? How much paper do I need for my project? These are the questions that power my circuits! Throughout this chapter, I'll be here to give you hints, share amazing math facts, and challenge you with tricky puzzles. Let's measure our world together!

Learning Outcomes

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

- Define perimeter and area and differentiate between them.
- Calculate the perimeter of regular and irregular polygons, including squares, rectangles, and triangles.
- Calculate the area of squares, rectangles, and triangles using appropriate formulas.
- Apply formulas to solve real-life word problems involving perimeter and area.
- Estimate the area of irregular shapes using a squared grid.
- Solve problems involving compound shapes by breaking them down into simpler figures.

From Last Year's Notebook

Let's connect what you already know to what we will learn next!

- You learned to measure the boundary of shapes by adding up all the side lengths. That was your first step in understanding **perimeter!**
- We will now use official formulas to find perimeter more easily. We will also explore a new, related concept: **area**, which measures the space a shape covers.

Real Math, Real Life

The chapter Perimeter and Area shows how measurements of shapes are used all around us in real life.

Here's a glimpse:

- **Architects** use them to design floor plans for buildings.
- **Farmers** calculate them to plan crop fields and fencing.
- **Artists** use them to frame paintings.
- **City planners** use them to design parks, roads, and public spaces.
- **Understanding** these concepts helps us make smart decisions in everyday life, from home decoration to construction projects.

Quick Prep

a) If you walk all the way around a square park, have you measured its area or its perimeter?
b) A rectangular photo has a short side of 10 cm and a long side of 15 cm. What is the total length of all its sides?
c) An ant walks 5 cm, then turns and walks 5 cm, turns again and walks 5 cm, and finally walks 5 cm back to where it started. What shape did its path make? How far did it walk?
d) Which do you think is longer: the perimeter of your textbook or the perimeter of your pencil box?
e) To put a fence around a garden, what measurement do you need to know?

Introduction

Welcome to the first part of our measurement journey! Here, we will focus on the perimeter. Imagine you are walking along the edge of a football field, or putting a decorative border on a greeting card. The total distance you walk or the total length of the border you use is the perimeter. In this section, we will learn how to calculate this "boundary length" for different shapes precisely and apply this skill to solve practical problems you see around you every day.

Chapter Overview

This chapter provides a structured journey into the concepts of perimeter and area.

- **Perimeter (The Boundary):** We start by defining perimeter as the total length of a shape's boundary. You will learn the specific formulas for calculating the perimeter of common shapes like rectangles, squares, and triangles. We'll explore practical applications such as fencing a field or framing a picture.
- **Area (The Space Inside):** Next, we explore area, the measure of the surface a shape covers. You will master the formulas for the area of rectangles and squares. This section connects to real world tasks like calculating the amount of carpet needed for a room or paint for a wall.
- **Area of a Triangle:** This special section shows how the area of a triangle relates to a rectangle, leading to its unique formula ($A = \frac{1}{2} \times b \times h$). We will see how this applies to objects like boat sails and flags.

From History

The concept of perimeter is ancient, born from practical needs. The word comes from the Greek words '**peri**' (around) and '**metron**' (measure). In ancient Egypt, farmers known as "**rope-stretchers**" used knotted ropes to measure the boundaries of their fields after the Nile River flooded. This simple act of measuring the distance around a plot of land was essential for farming and taxes, and it laid the foundation for the formal geometry later developed by the Greeks.

Perimeter of Rectilinear Figures

Perimeter is the total length of the boundary of a closed two-dimensional figure. For any polygon (a shape with straight sides), the perimeter is simply the sum of the lengths of all its sides. It's like taking a measuring tape and wrapping it around the outside of the shape. We measure perimeter in linear units like centimeters (cm), meters (m), or kilometers (km). In this section, we will learn the specific formulas for calculating the perimeter of common shapes.

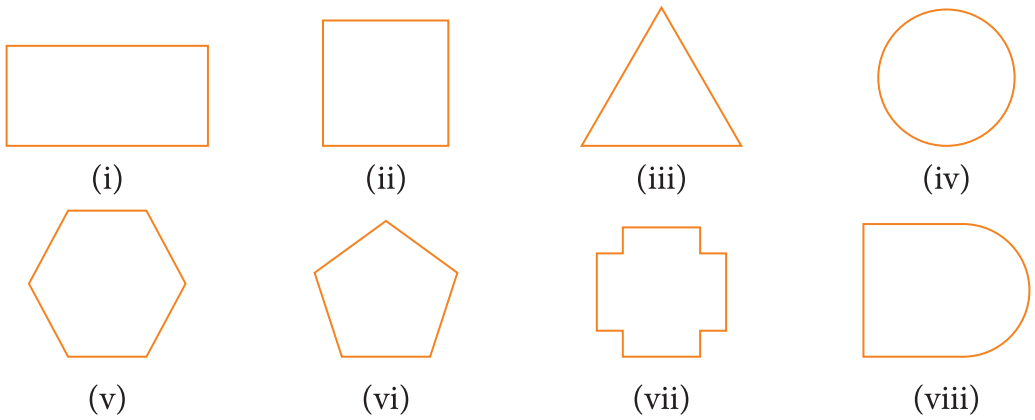


Fig. 6.1

Sub-concepts to be covered

1. Perimeter of a Rectangle
2. Perimeter of a Square
3. Perimeter of a triangle
4. Perimeter of a Regular Polygon

Perimeter of a rectangle

The perimeter of a rectangle is the total distance around the outer edge of the rectangle. It represents the sum of all four sides of the rectangle. A rectangle is a quadrilateral with opposite sides that are equal in length and four right angles. A Rectangle is a plane figure in which the longer pair of opposite sides is called **length** and other pair of shorter sides is called **breadth**.

To find the perimeter of a rectangle, you add together the lengths of all four sides. Since opposite sides of a rectangle are equal, the perimeter can be simplified using the formula:

$$P = 2 \times (l + w)$$

If P represents the perimeter of a rectangle ABCD, and l and b are the length and breadth (width) of the rectangle, then the perimeter is the sum of the lengths of all four sides. The sides of the rectangle are:

Fig. 6.2

AB = l (length) BC = b (breadth) CD = l (length) DA = b (breadth)

Thus, the perimeter can be written as: P = AB + BC + CD + DA

Substituting the lengths of the sides:

$P = l + b + l + b$

$P = 2l + 2b$

$P = 2 (l + b)$

Perimeter of rectangle = 2 (length + breadth)

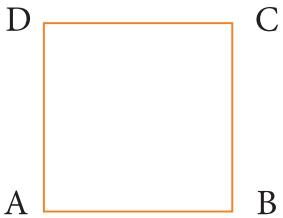


Fig. 6.3

Perimeter of a square

The perimeter of a square is the total length around the square, which is the sum of the lengths of all four equal sides. If P represents the perimeter and the length of each side of the square is a units, then:

P = AB + BC + CD + DA

Since all sides are of equal length, each side is a units. So, substituting the values for each side:

P = a + a + a + a

P = 4 × a units

Perimeter of square = 4 × length of each side

Perimeter of a triangle

The perimeter of a triangle is the sum of the lengths of its three sides. If the lengths of the sides of the triangle are l then the perimeter P can be calculated using the formula:

For triangle △ABC:

- The perimeter P is the sum of the lengths of its three sides: AB, BC, and CA.
- Therefore, the perimeter is given by:

  P = AB + BC + CA

  for equilateral triangle

  P = $l + l + l = 3 \times l$ units

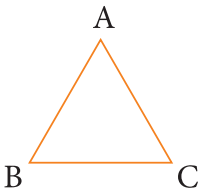


Fig. 6.4

Perimeter of triangle = 3 × length of each side

Perimeter of a Regular Polygon

A regular polygon is a polygon in which all sides are of equal length, and all interior angles are of equal measure. Common examples of regular polygons include equilateral triangles, squares, pentagons, hexagons, and so on.

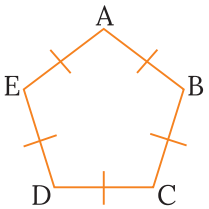


Fig. 6.5

The perimeter of any pentagon is the total length of its five sides.

Perimeter of regular pentagon = AB + BC + CD + DE + EA = AB + AB + AB + AB + AB

Perimeter = 5 × length of one side

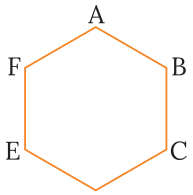


Fig. 6.6

Similarly, perimeter of regular hexagon = 6 × length of one side

Let us see some examples.

Example 1 : Find the perimeter of the figure 6.7.

Solution: Perimeter of rectilinear figure = Sum of all sides

= 11 + 2 + 2 + 19 + 3 + 14 + 9 + 7

= 66 cm

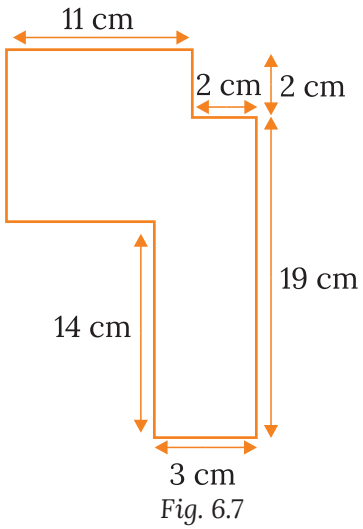


Fig. 6.7

Example 2 : In a pentagon, the lengths of four sides are 10 cm, 15 cm, 12 cm, and 8 cm. The perimeter of the pentagon is 55 cm. Find the length of the missing side.

Solution: Let the unknown side be x cm.

The sides of the pentagon are:

The perimeter is the sum of the lengths of all five sides. The equation for the perimeter is:

Perimeter = 10 + 15 + 12 + 8 + x

You are given that the perimeter is 55 cm, so: 55 = 10 + 15 + 12 + 8 + x

Simplifying the sum of the known sides:

55 = 45 + x

55 − 45 = x

x = 10 cm

The missing side is x = 10 cm

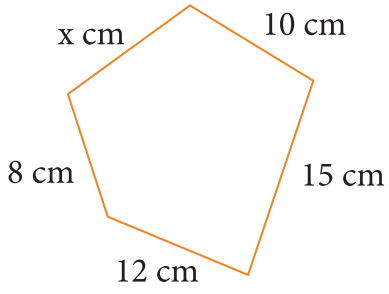


Fig. 6.8

Example 3 : In a triangle, the lengths of two sides are 9 cm and 7 cm. The perimeter of the triangle is 30 cm. Find the length of the third side.

Solution: Let the unknown side be x cm.

The sides of the triangle are:

The perimeter is the sum of the lengths of all three sides. Therefore, the equation for the perimeter is: Perimeter = 9 + 7 + x

You are given that the perimeter is 30 cm, so: 30 = 9 + 7 + x

Simplifying:

30 = 16 + x

30 − 16 = x

x = 14 cm

The missing side is x = 14 cm.

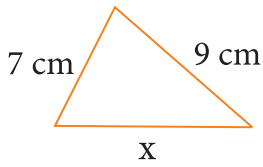


Fig. 6.9

Example 4 : Find the perimeter of the following shapes:

a) A rectangle with dimensions 8 cm by 12 cm.

b) A quadrilateral with sides 9 cm, 5 cm, 8 cm, and 7 cm.

c) A triangle with sides 6 cm, 10 cm, and 8 cm.

Solution: a) Perimeter = 8 cm + 12 cm + 8 cm + 12 cm = 40 cm

b) Perimeter = 9 cm + 5 cm + 8 cm + 7 cm = 29 cm

c) Perimeter = 6 cm + 10 cm + 8 cm = 24 cm

Example 5 : A farmer has a rectangular field of length 500 m and breadth 350 m. He wants to fence it with 6 rounds of wire. What is the total length of wire required for fencing?

Solution: Perimeter of rectangular field = 2(500 + 350) = 2 × 850 = 1700 m

Total length of wire required = 6 × 1700 = 10,200 m

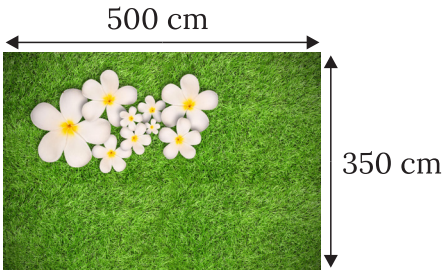


Fig. 6.10

Example 6 : Meera and Sunil go for jogging every morning. Meera jogs around a 150-meter square field, and Sunil jogs around a rectangular field with dimensions 250 m by 150 m. If they both take 4 rounds each, who covers the greater distance?

Solution: Perimeter of square field = 4 × 150 = 600 m

Perimeter of rectangular field = 2(250 + 150) = 2 × 400 = 800 m

Sunil covers 800 m - 600 m = 200 m more in one round.

Therefore, Sunil will cover 4 × 200 = 800 m more than Meera in 4 rounds.

Knowledge Checkpoint

1. What is the difference between length and perimeter?
2. Calculate the perimeter of a square with a side of 9 cm.
3. A rectangle has a perimeter of 30 cm and a length of 10 cm. What is its breadth?

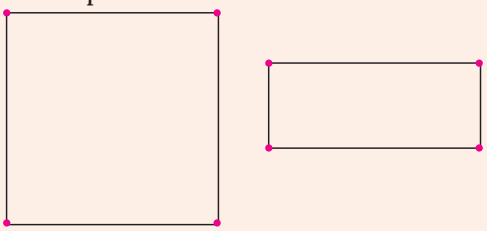
Activity

Same Perimeter, Different Shapes

Objective: To explore whether two different shapes can have the same perimeter.

Materials:

- Graph/Grid paper
- Pencil and eraser
- Ruler



Procedure:

- Work individually or in pairs.
- On graph paper, draw a **rectangle** with length 8 units and breadth 2 units.
- Next, draw a **square** whose side is 5 units.
- Measure the sides of both shapes and calculate their perimeters.
- Check: Are the perimeters the same?
- Try to draw at least **two more pairs of shapes** (rectangles, squares, or irregular shapes) that have the same perimeter but look different.
- Take one more such scenario, say perimeter 38 units. Try to draw at least 3 figures with the same perimeter.
- Display your drawings on a class bulletin board for comparison.

- **Inquiry Question:** Is it possible for two shapes to have the same perimeter but look very different? Can you keep creating more such pairs?

Key Terms

- **Perimeter:** The total distance or length of the boundary of a closed two-dimensional figure.
- **Polygon:** A closed plane figure with three or more straight sides.
- **Rectangle:** A four-sided polygon with opposite sides equal and all angles at 90 degrees.
- **Square:** A rectangle with four equal sides.
- **Length (l):** The longer side of a rectangle.
- **Breadth (b):** The shorter side of a rectangle.

Do It Yourself

Imagine you have a piece of string that is 36 cm long. You can bend it to form a square or a rectangle.

- If you form a square, what would be the length of its side?
- Can you form a rectangle with a length of 10 cm? What would its breadth be?
- Can you form a different rectangle? What are its dimensions? Which shape do you think covers more space inside? We'll explore this in the next section!

Facts Flash

- Did you know that for a given perimeter, a circle encloses the largest possible area? That's why bubbles are round!
- The word "**perimeter**" was used by the ancient Greeks. If you break it down, "**peri**" means "**around**" and "**metron**" means "**measure**." So, it literally means "**to measure around**"!

Mental Mathematics

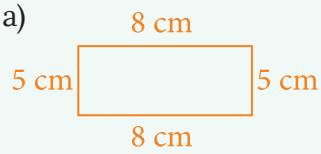
- The length of a rectangle is 14 cm and the breadth is 6 cm. What is its perimeter?
- A rectangle has a perimeter of 50 cm. If its length is 15 cm, what is its breadth?
- The perimeter of a square is 24 cm find the side of the square.
- Which has a larger perimeter – a square of side 8 cm or a rectangle of length 10 cm and breadth 6 cm?

Exercise 6.1

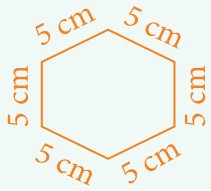
Gap Analyzer™ Homework | Watch Remedial

1. Find the perimeter of the following shapes:

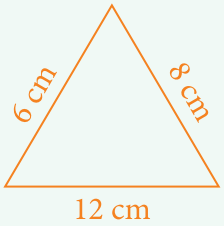
a)



b)



c)



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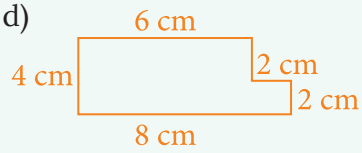
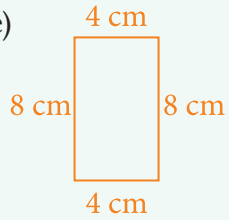


e)



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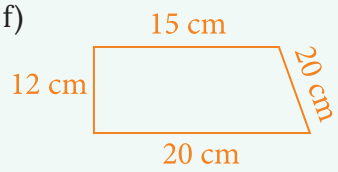
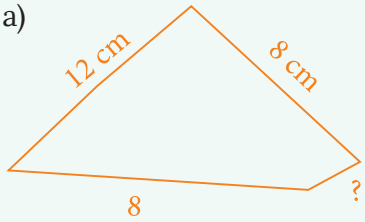


2. Find the missing length if the perimeter of the figure is 30 cm:

a)



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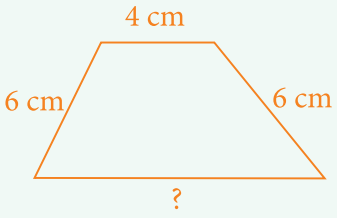

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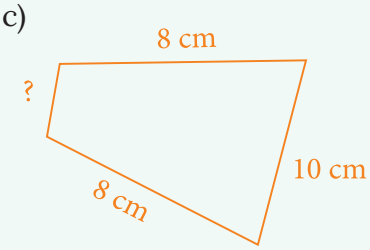
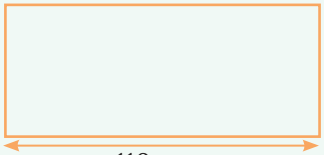


3. A farmer has a rectangular field of length 180 m and breadth 120 m. He wants to fence it with 5 rounds of wire. What is the total length of wire required for fencing?
4. Find the cost of fencing a rectangular park of length 200 m and breadth 150 m at the rate of 15 per meter.
5. **A string is 50 cm long. What will be the length of each side if the string is used to form:**
   a) An equilateral triangle. b) A square. c) A regular hexagon.
6. A rectangular table-top measures 1 m 80 cm by 1 m 20 cm. Maria wants to make a table cloth such that it extends 50 cm beyond the edges of the table on all four sides. What will be the perimeter of the table cloth?

7. Kiran and Ravi go for jogging every morning. Kiran jogs around a 150-meter square field, and Ravi jogs around a rectangular field with dimensions 250 m by 120 m. If they both take 4 rounds each, who covers the greater distance and by how much?
8. Find the missing side of the figure if the perimeter of a quadrilateral is 50 cm and three of the sides measure 15 cm, 12 cm, and 10 cm.
9. If the perimeter of the given rectangle is 880 cm, then what will be the breadth?



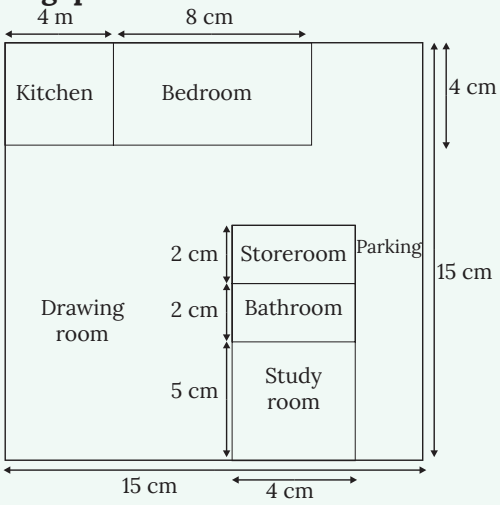
10. Look at the following map of a house and answer the following questions:

a) What is the perimeter of the Bedroom?

b) What will be the total perimeter of Storeroom and Bathroom, if they are considered as one?

c) Determine the perimeter of Study room.

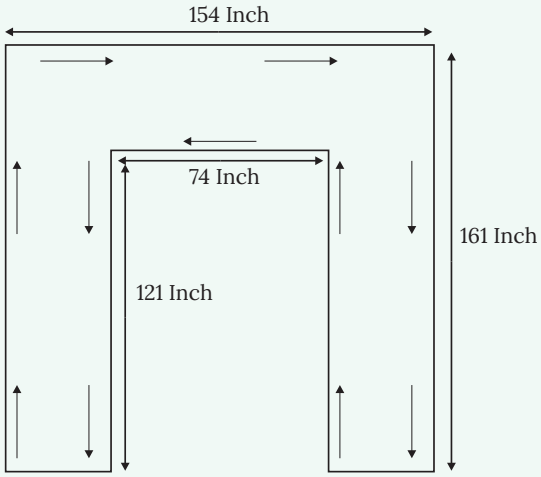
d) If a boundary has to be made around the complete house, what will be the length of the total boundary?



11. The students of Grade 6 are decorating their school corridor for the upcoming Science Fair. The corridor has a U-shape as shown in the floor plan below. They want to stick a decorative border along the bottom of all the walls.

a) Calculate the total length of the border they need.

b) If the border tape costs ₹20 per inch, what will be the total cost to decorate the entire corridor?



Area of Rectangles and Squares

Now that we've mastered measuring the boundary of a shape, let's move inside! Area tells us how much flat space a shape covers. If perimeter is the fence, area is the garden itself. If perimeter is the picture frame, area is the picture. In this section, you'll learn how to calculate the area of rectangles and squares, a skill essential for everything from tiling a floor to painting a wall or even designing a video game level.

Area and Its Units

Area is the measure of the region or surface enclosed within a closed boundary. Unlike perimeter, which is a length, area is a measure of space and is expressed in **square units**, such as **square centimeter**s

(cm^2), square meters (m^2), or square kilometers (km^2). A square unit is literally a square with sides of 1 unit (e.g., 1 cm by 1 cm). The area of a shape is the number of these square units that can fit inside it without overlapping.

Sub-concepts to be covered

1. The Concept of Area and Square Units
2. Area of a Square
3. Finding Area using Square paper
4. Area of a Rectangle

Units of Area

Area is usually measured in square units. For example, if the length and width of a rectangle are measured in centimeters, the area will be measured in square centimeters (cm^2).

Common units of area include:

- Square meters (m^2)
- Square centimeters (cm^2)
- Square kilometers (km^2)
- Square inches (in^2)
- Square feet (ft^2)

Conversion of Units of Area:

1 square meter (m^2)	100 × 100 square centimeters (cm^2)	10,000 cm^2
1 square meter (m^2)	10 × 10 square decimeters (dm^2)	100 dm^2
1 square centimeter (cm^2)	10 × 10 square millimeters (mm^2)	100 mm^2
1 square kilometer (km^2)	1,000 × 1,000 square meters (m^2)	1,000,000 m^2
1 square hectometer (hm^2)	(100 × 100) square meters (m^2)	10,000 m^2 = 1 hectare (ha)
1 square decameter (dam^2)	10 × 10 square meters (m^2)	100 m^2 = 1 are (a)

Table 6.1

Additional Conversions

- 1 square decimeter (dm^2) = 10 × 10 square centimeters (cm^2) = 100 cm^2
- 1 square kilometer (km^2) = 100 hectares (ha)
- 1 acre = 4,046.856 square meters (m^2)
- 100 acres = 1 hectare (ha)

Area of a Square

A square is a special type of rectangle where all four sides are of equal length. This means that the length and breadth of a square are the same. In other words, all sides of a square have the same measurement.

The area of a square is the amount of space it covers on a flat surface. Since all sides are equal, we can simply multiply the length of one side by itself to find the area.

Area of Square = Side × Side

Or, we can write it as: Area = $Side^2$

Where Side is the length of one side of the square.

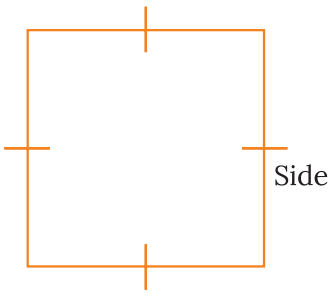


Fig. 6.11

Finding Area Using Square Paper

Square paper (also known as graph paper) is a useful tool for finding the approximate area of a closed figure. The paper is divided into small squares, each with side length of 1 cm, as shown below.

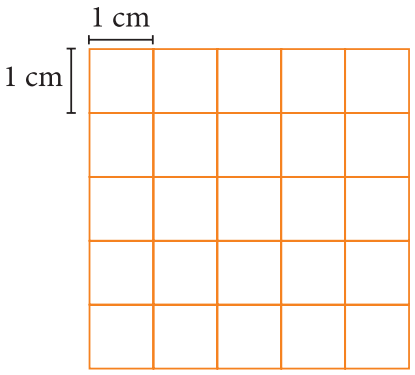


Fig. 6.12

Steps to Find the Area of a Closed Figure Using Square Paper:

1. **Place the Figure on the Square Paper:** Position the given closed figure on the graph paper and trace its outline.
2. **Count Complete Squares:** If the figure encloses an exact number of complete squares, simply count them. This number is the area of the figure in square centimeters.
3. **Handle Partial Squares:** If the outline cuts through the squares, follow these steps:
   - **Count Complete Squares:** Count the squares fully enclosed by the figure. Let this count be n.
   - **Count More Than Half Squares:** Count the squares where more than half of the square is enclosed. Let this count be m.
   - **Count Exactly Half Squares:** Count the squares that are exactly half enclosed. Let this count be p.
   - **Ignore Small Squares:** Do not count the squares where less than half of the square is enclosed.
4. **Calculate the Area:** Use the following formula to estimate the area:

   Approximate Area $= n + m + \frac{p}{2}$ square centimeters

Example 7 : Find the area of the triangle given on the grid paper.

Solution: Let's use square paper to find the area of a triangle. Suppose the triangle is drawn on the square paper as shown below:

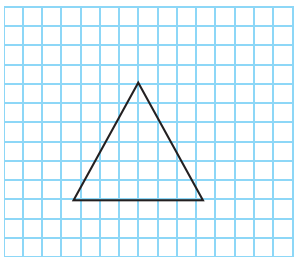


Fig. 6.13

1. Count the number of complete squares inside the triangle. This is n = 12.
2. Count the number of squares where more than half is enclosed. This is m = 6.
3. Count the number of squares where exactly half is enclosed. This is p = 0.

Now, using the formula to calculate the approximate area:

Area = 12 + 6 + 0 = 12 + 6 = 18 sq cm

So, the approximate area of the triangle is 18 square centimeters.

Example 8 : A photo frame has a wooden border of uniform width 3 cm on each side. The inner photo has dimensions 12 cm by 12 cm. Find the area of the wooden border.

Solution: Side of inner photo = 12 cm

Area of inner photo = Side × Side

= 12 × 12 = 144 cm^2

Side of outer frame = 12 + 3 + 3 = 18 cm

Area of inner photo = Side × Side

= 18 × 18 = 324 cm^2

Area of wooden border = 324 – 144 = 180 cm^2

Fig. 6.14

Example 9 : The area of a square field is 49 sq meters. Find the length of one side of the square.

Solution: Area of square = Side × Side

49 = $Side^2$ ⇒ Side = $\sqrt{49}$ = 7 meters

Area of a rectangle

In our daily lives, we come across different shapes like books, tables, and doors, which are often in the shape of rectangles. To understand the size or space inside these shapes, we need to calculate their area

The area of a rectangle is the amount of space it covers on a flat surface. To find the area, we multiply the length of the rectangle by its width (or breadth).

Fig. 6.15

Formula for the Area of a Rectangle:

Area of Rectangle = Length × Width

Where:

- Length is the longer side of the rectangle.
- Width (or Breadth) is the shorter side of the rectangle.

Now, let's derive the formula for finding the area of a rectangle when its length and breadth are given. Suppose we need to find the area of rectangle ABCD, where the length is 5 cm and the breadth is 6 cm.

Rectangle 5 cm × 6 cm = 30 cm

To do this, imagine the rectangle divided into small squares, each with an area of 1 square centimeter. By counting all the squares inside the rectangle, we find there are 30 squares in total.

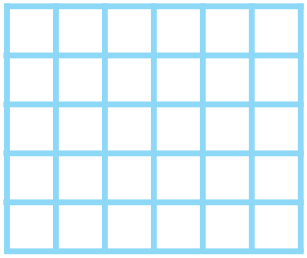


Fig. 6.16

Thus, the area of rectangle ABCD = 30 square centimeters, which can also be expressed as:

Area = 5 cm × 6 cm = 30 sq cm

From these examples, we can conclude that the area of any rectangle is given by the formula:

Area of Rectangle = Length × Breadth

This formula helps us calculate the area of any rectangle as long as we know the length and the breadth.

Example 10 : Find the area of a floor with dimensions 10 meters by 6 meters.

Solution: Area = Length × Breadth

Area = 10 × 6 = 60 sq meters

Example 11 : A rectangular garden has a length of 20 meters and a width of 15 meters. Find its area.

Solution: Area = Length × Width

Area = 20 × 15 = 300 sq meters

Example 12 : A floor has a length of 8 meters and a width of 5 meters. A carpet of size 3 meters by 4 meters is laid. Find the area of the floor that is not covered by the carpet.

Solution: Area of floor = Length × Width

Area of floor = 8 × 5 = 40 sq meters

Area of carpet = Length × Width

Area of carpet = 3 × 4 = 12 sq meters

Area not covered = Area of floor − Area of carpet

Area not covered = 40 − 12 = 28 sq meters

Example 13 : A square has a perimeter of 24 meters. Find its area.

Solution: Perimeter of square = 4 × Side

$24 = 4 \times \text{Side} \Rightarrow \text{Side} = \frac{24}{4} = 6\text{m}$

Area of square = Side × Side

Area = 6 × 6 = 36 sq meters

Example 14 : How many square tiles of size 4 cm × 4 cm are needed to cover a floor of size 12 cm × 16 cm?

Solution: Area of the floor = Length × Breadth

Area of floor = 12 × 16 = 192 sq cm

Area of each tile = Side × Side

Area of tile = 4 × 4 = 16 sq cm

$$\text{Number of tiles} = \frac{\text{Area of floor}}{\text{Area of tile}}$$

$$\text{Number of tiles} = \frac{192}{16} = 12$$

Example 15 : A rectangle of size 15 units × 10 units. If you want to draw another rectangle inside it, without touching the outer rectangle that occupies exactly half the area of the outer rectangle. What will be the required dimensions?

Solution: Given dimensions of the rectangle: 15 units × 10 units

Area of this rectangle = 15 × 10 = 150 sq units

The area of the inner rectangle should be half of the area of the outer rectangle: Area of inner rectangle = $\frac{150}{2}$ = 75 sq units

Now, we need to find the possible combinations for the sides of the inner rectangle:

- ✶ 1 × 75
- ✶ 3 × 25
- ✶ 5 × 15
- ✶ 6 × 12.5
- ✶ 7.5 × 10

The condition is that the inner rectangle should not touch the outer rectangle. Hence, the best dimensions that fit this condition are 6 units × 12.5 units, as they fit neatly within the outer rectangle without touching its sides.

The dimensions of the required inner rectangle are 6 units × 12.5 units.

Example 16 : On the four corners of a rectangular lawn, four flower beds, each 3 meters long and 2 meters wide, are dug. Find the area of the remaining part of the lawn if the length of the lawn is 12 meters and the width is 10 meters.

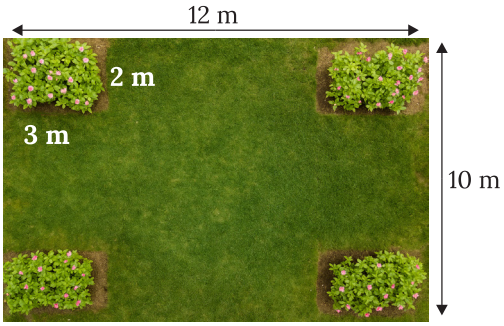


Fig. 6.17

Solution: **The dimensions of the lawn:** 12 meters × 10 meters

Area of the lawn = 12 × 10 = 120sq meters

The area of one flower bed: Area of one flower bed = 3 × 2 = 6 sq meters

The area of four flower beds: Area of four flower beds = 4 × 6 = 24 sq meters

The area of the remaining part of the lawn:

Area of remaining lawn = Area of lawn − Area of four flower beds Area of remaining lawn

= 120 − 24 = 96 sq meters

The area of the remaining part of the lawn is 96 sq meters.

Knowledge Checkpoint

1. What is the area of a square with a perimeter of 20 cm?
2. A rectangle has an area of 50 cm² and a length of 10 cm. What is its breadth?
3. Why is area measured in 'square' units?

Activity

- **Objective:** To understand area by creating shapes with a specific area on a grid.
- **Materials:** 1 cm grid paper (graph paper), colored pencils.
  1. Your task is to draw a robot using only squares and rectangles.
  2. The head must be a square with an area of 16 cm².
  3. The body must be a rectangle with an area of 30 cm².
  4. Each arm must be a rectangle with an area of 12 cm².
  5. Each leg must be a rectangle with an area of 18 cm².
  6. Draw the robot on the grid paper. Label the dimensions (length and breadth) of each part.
- **Inquiry Question:** Can you draw a rectangle with an area of 30 cm² in different ways? (e.g., 5 × 6, 3 × 10, 2 × 15). How does the shape change?

Key Terms

- **Area:** The measure of the surface enclosed by a closed figure.
- **Square Unit:** The basic unit of area, representing a square with sides of one unit length (e.g., cm², m²).
- **Grid:** A network of horizontal and vertical lines used for locating points or measuring area.

Do It Yourself

You have 24 square tiles, each 1 cm by 1 cm. You want to arrange them to form a rectangle.

- What are all the possible lengths and breadths of the rectangles you can make? (e.g., 1 × 24, 2 × 12, etc.)
- Calculate the perimeter for each of these rectangles.
- Which rectangle has the smallest perimeter? Which has the largest? What do you notice?

Facts Flash

- The area of your skin is about 2 square meters!
- A hectare is a unit of area commonly used for land, equal to 10,000 square meters. That's roughly the size of two football fields!
- Sometimes, two different shapes can have the same area but different perimeters.

Mental Mathematics

- What is the area of a square with side 7 cm?
- A rectangle is 8 cm long and 5 cm wide. What is its area?
- On a square paper grid, a rectangle covers 6 squares in one row and 4 rows. What is its area in square units?
- A square has an area of 64 cm^2. What is the length of one side?
- If a rectangle has an area of 36 cm^2 and a length of 9 cm, what is its breadth?

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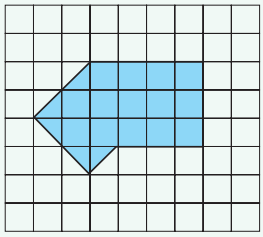
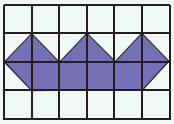
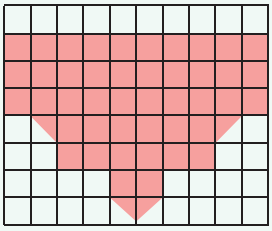
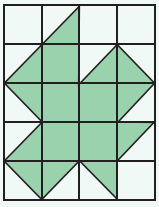
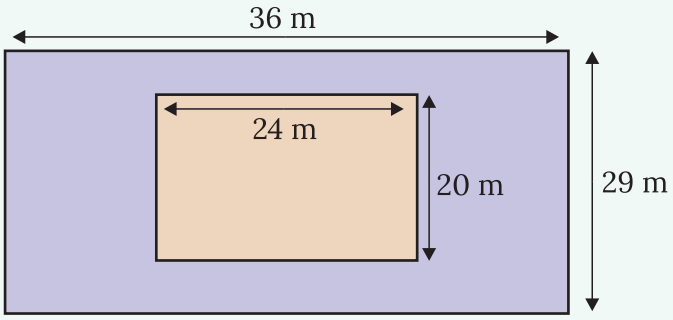
Exercise 6.2

1. **Find the area of a rectangular garden with dimensions:**
   a) 8 m by 6 m b) 14 m by 7 m c) 11 m by 9 m
2. **Provide the missing information in the blank:**
   Length (cm) : 6, 5, 10, 12 **Breadth (cm) :** 3, 4, 4, 5 **Area (sq cm) :** 18, 20, 40, ___
3. **Find the area of the following figures:**
   a) 
   b) 
   c) 
   d) 
4. A rectangular swimming pool is 50 m long and 25 m wide. If a square tile of side 2 m is used to cover the pool, how many tiles will be required?
5. The length of a rectangle is 4 more than twice its width. If its perimeter is 44 cm, then find the area of the rectangle.
6. Two plots of land have the same perimeter. One is a square with side 50 m and the other is a rectangle with a width of 30 m. Find the length of the rectangle. Which plot has the greater area, and by how much?

7. **Manni and Anjali were given a task to decorate the school auditorium. The auditorium has a big rectangular floor. Inside it, there is a smaller rectangular stage. Manni was asked to cover the purple color region with carpet, while Anjali was asked to cover the cream color region with glitter. Who covered the larger area?**



8. The perimeter of a rectangle is 60 meters. If the length is 18 meters, find the width of the rectangle and its area.
9. How many square tiles of size 2 m × 2 m are needed to cover a rectangular floor of size 20 m × 15 m?
10. The dimensions of a rectangular garden are 30 m × 10 m. If a square of side 5 m is removed from each corner, find the remaining area of the garden.
11. **Arjun is trying to decide between two new phones, the "VisionMax" and the "ScreenPro". He wants the phone with the largest screen area for watching videos.**
    - The VisionMax screen is 16 cm long and 7 cm wide.
    - The ScreenPro screen is 14 cm long and 8 cm wide.

    Which phone should Arjun choose? Calculate the area of both screens to justify your answer.
12. The school's art club has been given a roll of cork sheet that has a total area of 6 square meters to make a new bulletin board. The wall where the board will be placed has a height of 2 meters, so the board must be 2 meters tall. To use the entire cork sheet without any wastage, what should be the width of the bulletin board?

Area of a Triangle

We've explored shapes with four straight sides, but what about the simplest polygon, the triangle? Triangles are everywhere—in the sails of a boat, the trusses of a bridge, and even a slice of pizza! Measuring the space inside a triangle is a bit different from a rectangle. In this section, we will uncover the clever relationship between triangles and rectangles to find a simple formula for the area of any triangle.

Calculating the area of a triangle requires two key measurements: its **base** and its **height**. The base can be any of the three sides of the triangle. The height is the perpendicular distance from the base to the opposite vertex (corner). The most important discovery is that any triangle is exactly half of a rectangle (or parallelogram) that shares the same base and height. This relationship gives us a simple and powerful formula.

Sub-concepts to be covered

1. Identifying the Base and Height of a Triangle
2. The Relationship Between a Triangle and a Rectangle
3. The Formula for the Area of a Triangle

Mathematical Explanation

Identifying the Base and Height of a Triangle

- **Base (b):** Any side of a triangle can be chosen as its base.
- **Height (h):** The height is the length of the perpendicular line segment drawn from the vertex opposite the base, down to the base. In a right-angled triangle, one of the sides is the height. In other triangles, the height might be inside or even outside the triangle.
- **Key Point:** The height must be perpendicular (at a 90° angle) to the base.

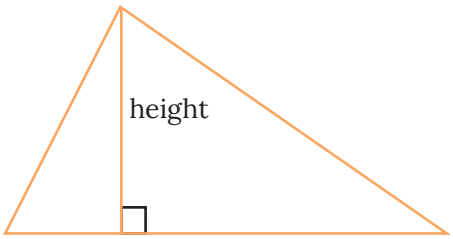


Fig. 6.18

The Relationship Between a Triangle and a Rectangle

If you take any rectangle and draw a diagonal, you split it into two identical (congruent) right-angled triangles.

- The area of each triangle is exactly half the area of the rectangle.
- Area of Rectangle = base × height.
- Area of Triangle = $\frac{1}{2}$ × (Area of Rectangle) = $\frac{1}{2}$ × base × height.

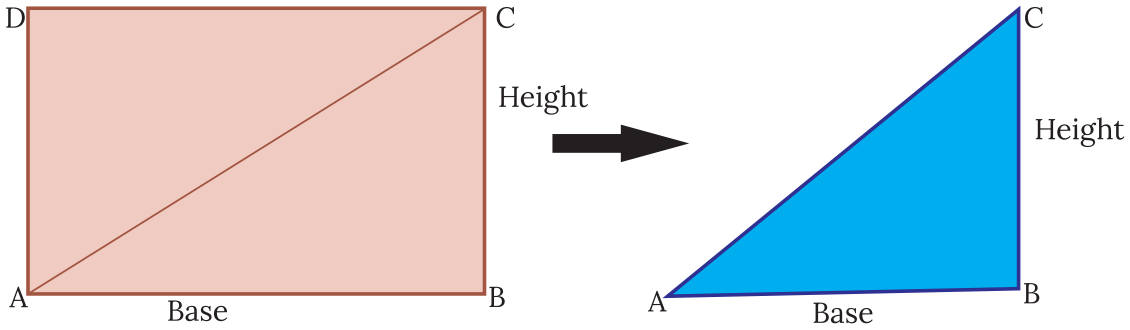


Fig. 6.19

The Formula for the Area of a Triangle

The area of a triangle is half the product of its base and its corresponding height.

Formula: Area (A) = $\frac{1}{2}$ × base × height or A = $\frac{1}{2}$ bh.

Example: A triangle with a base of 10 cm and a height of 6 cm has an area of $\frac{1}{2}$ × 10 × 6 = 30 cm².

The area of a triangle is given by the formula : **Area of Triangle = $\frac{1}{2}$ × Base × Height**

Where:

- Base is the bottom side of the triangle.
- Height is the distance from the base to the top vertex (the point opposite the base), measured at a right angle (90°) to the base.

Why Do We Use $\frac{1}{2}$ in the Formula?

The reason we multiply by $\frac{1}{2}$ is that a triangle is half of a rectangle. If you draw a rectangle and divide it in half, you'll get two triangles. So, the area of a triangle is half the area of a rectangle.

Take a rectangular piece of paper and cut it along one of its diagonals, forming two triangles. Do these two triangles overlap each other exactly? Can we conclude that the two triangles have equal areas?

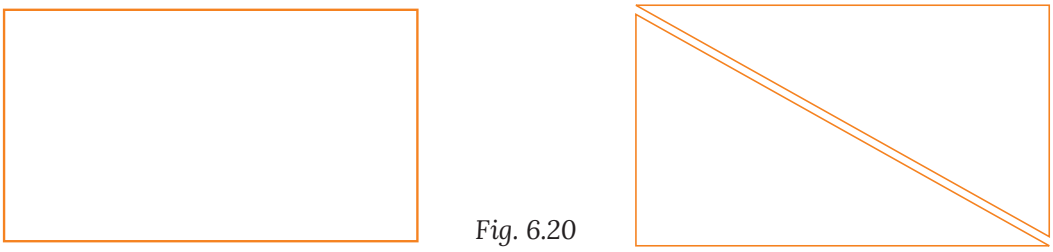


Fig. 6.20

Example 17 : The area of a triangle is 36 cm², and the base is 12 cm. Find the height of the triangle.

Solution: We know the formula for the area of a triangle is:

$$\text{Area} = \frac{1}{2} \times \text{Base} \times \text{Height}$$

Given:

Area = 36 cm², Base = 12 cm

Substitute the given values into the formula:

$$36 = \frac{1}{2} \times 12 \times \text{Height}$$

So, the height of the triangle is 6 cm.

Example 18 : A triangle has a height of 9 cm and a base that is twice its height. What is the area of the triangle?

Solution: Let the height of the triangle be h = 9 cm. The base is twice the height, so:

Base = 2 × 9 = 18 cm

Now, using the formula for the area of a triangle:

$$\text{Area} = \frac{1}{2} \times \text{Base} \times \text{Height}$$

Substitute the values:

$$\text{Area} = \frac{1}{2} \times 18 \times 9 = \frac{1}{2} \times 162 = 81 \text{ cm}^2$$

So, the area of the triangle is 81 cm².

Example 19 : A triangular flag has a base of 20 cm and a height of 15 cm. How much area does the flag cover?

Solution: Using the formula for the area of a triangle:

$$\text{Area} = \frac{1}{2} \times \text{Base} \times \text{Height}$$

Given:

Base = 20 cm, Height = 15 cm

Substitute the given values into the formula:

$$\text{Area} = \frac{1}{2} \times 20 \times 15 = \frac{1}{2} \times 300 = 150 \text{ cm}^2$$

So, the area of the flag is 150 cm².

Knowledge Checkpoint

1. If the base of a triangle is doubled but the height is kept the same, what happens to its area?
2. Can the height of a triangle be one of its sides? In which case?
3. Find the area of a triangle with a base of 14 cm and a height of 5 cm.

Activity

Paper Proof

- **Objective:** To visually verify that the area of a triangle is half the area of a rectangle with the same base and height.
- **Materials:** Two identical sheets of colored paper, scissors, a ruler, glue.
- **Procedure:**
  1. Take one sheet of paper. This is your rectangle. Measure its length (base) and breadth (height) and calculate its area.
  2. Take the second identical sheet of paper.
  3. Draw a diagonal line from one corner to the opposite corner.
  4. Carefully cut along this diagonal. You now have two identical right-angled triangles.
  5. Take one of the triangles. Does it cover exactly half of the first uncut sheet of paper?
  6. Calculate the area of the triangle using the formula $A = \frac{1}{2}$ bh. Does your calculation match half the area of the rectangle?
- **Inquiry Question:** What if you cut the paper to form a non-right-angled triangle? Can you still show it's half of a related parallelogram?

Key Terms

- **Base (of a triangle):** The side of a triangle from which the height is measured.
- **Height (of a triangle):** The perpendicular distance from the base to the opposite vertex.
- **Vertex:** A corner point of a polygon.
- **Perpendicular:** At an angle of 90 degrees.

Do It Yourself

Can two triangles with very different shapes have the same area?

- Try to draw a triangle with a base of 10 cm and a height of 6 cm. Calculate its area.
- Now, try to draw a different-looking triangle (perhaps a long, skinny one) that has the same area. What could its base and height be? **(Hint:** You need $\frac{1}{2} \times b \times h$ to be the same value).

Facts Flash

- The Bermuda Triangle, a famous region in the Atlantic Ocean, has an approximate area of 1.3 million square kilometers!
- Any polygon, no matter how complex, can be broken down into a set of triangles. This process, called triangulation, is fundamental in computer graphics and engineering.

Mental Mathematics

- **Strategy:** Half First. When calculating A = $\frac{1}{2}$ bh, if either the base or height is an even number, half it first before multiplying.
  - **Example:** A = $\frac{1}{2}$ × 14 × 9. Think: Half of 14 is 7. Now, 7 × 9 = 63. So, A = 63.
  - **Example:** A = $\frac{1}{2}$ × 15 × 8. Think: Half of 8 is 4. Now, 15 × 4 = 60. So, A = 60.
- **Quick Calculations:**
  1. Area of a triangle, b = 12, h = 5? ($\frac{1}{2}$ of 12 is 6. 6 × 5 = 30)
  2. Area of a triangle, b = 10, h = 9? ($\frac{1}{2}$ of 10 is 5. 5 × 9 = 45)
  3. Area of a triangle, b = 7, h = 6? ($\frac{1}{2}$ of 6 is 3. 7 × 3 = 21)

Exercise 6.3

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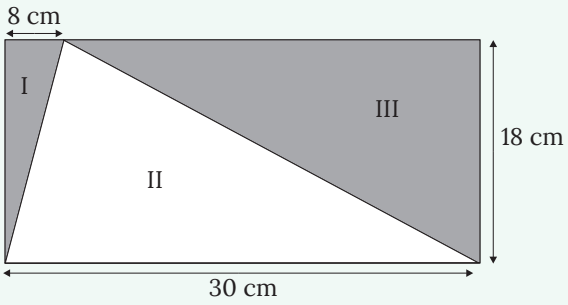
1. The base of a triangle is 12 meters, and the height is 9 meters. What is the area of the triangle?
2. Find the area of a right-angled triangle with a base of 14 cm and a height of 8 cm.
3. The base and height of a triangle are in the ratio 2:5. If the area of the triangle is 45 m^2. Determine the value of base and height of the triangle.
4. The area of a triangle is 42 cm^2, and its height is 7 cm. What is the base of the triangle?
5. **Does the following statement stand True (T) or False (F):**
   a) If the base of a triangle is doubled and the height remains the same, the area of the triangle will also double.
   b) The area of a triangle is always half of the area of a rectangle with the same base and height.
   c) The height of a triangle can be found by dividing the area by the base.
   d) If the height of a triangle is zero, its area will be zero.
   e) The area of a triangle depends only on its base, not on its height.
   f) The area of a right-angled triangle is always half of the area of a square with the same base and height.
6. Anjali is a city gardener. She has been given a small bag of special fertilizer that can cover an equilateral triangular plot of land with an area of exactly 12 square meters. She has designed a plot where the height is 4 meters. To use the fertilizer perfectly without any waste, what should be the length of the base of her triangular garden plot? What will be the perimeter of the triangular plot?
7. **A company manufactures road safety signs. They are comparing two designs for a new triangular warning sign. To be effective at night, the sign must have the largest possible reflective area.**
   - **Design A:** A triangle with a base of 60 cm and a height of 80 cm.
   - **Design B:** A triangle with a base of 70 cm and a height of 70 cm.

   Which design should the company choose to maximize the reflective area? Show your calculations to prove your choice.

8. Determine the area of triangle I, II and III, formed by dividing the rectangle.



9 Side I of a right-angled triangle is 3 more than thrice side II and side III is 1 more than side I. If the perimeter of the triangle is 56 m, then find its area.

10. The municipal corporation decided to build a small triangular park on a vacant piece of land. The park is triangular in shape with a base of 18 m and a height of 12 m. Inside the park, there will be a triangular flower bed with a base of 9 m and a height of 6 m.

The rest of the park will be used for walking paths and benches.

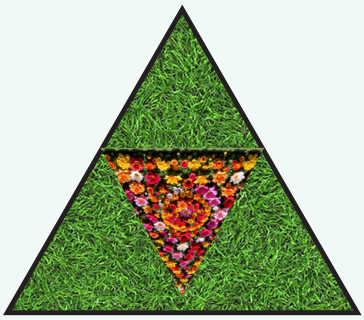
Answer the following questions:

a) What is the area of the entire triangular park?

b) What is the area of the flower bed?

c) How much area is left for walking paths and benches?

d) If the cost of planting grass on the remaining area is ₹20 per m^2, what will be the total cost?



Common Misconceptions

Misconception: Thinking that if two shapes have the same perimeter, they must have the same area.
Correction: This is incorrect. A long, thin rectangle can have the same perimeter as a square, but the square will have a much larger area. For example, a 17 × 1 rectangle and a 9 × 9 square both have a perimeter of 36 units. But their areas are 17 sq. units and 81 sq. units, respectively. Always remember: Perimeter is the fence (length), Area is the garden (space).

Misconception: Writing the area as '50 cm' instead of '50 cm^2'.
Correction: Perimeter is a length, so it's measured in cm, m, etc. Area measures a surface covered by squares, so it must be in square units (cm^2, m^2). The '2' in cm^2 reminds you that area involves multiplying two lengths (like length × breadth).

Misconception: Using the slanted side of a triangle as its height.
Correction: The height of a triangle must be perpendicular (form a 90° angle) to the base. It's the true 'vertical' height, not the length of a sloping side (unless it's a right-angled triangle). Always look for the right-angle symbol or the line that goes straight up from the base to the opposite corner.

Real-Life Perimeter and Area: Mathematical Application

Here's how we use perimeter (the distance around a shape) and area (the space inside it) in everyday tasks:

- **Home Decorating:** You use perimeter to measure the length of festive lights needed to go around a window. You use area to calculate how much carpet is needed to cover the entire floor of that same room.
- **Gardening and Fencing:** To build a fence, you must calculate the perimeter of your garden to buy the right amount of fencing material. To buy the right amount of fertilizer, you need the garden's area.
- **Art and Craft:** When putting a border on a handmade card, you measure its perimeter. The space available for your drawing or message is the card's area.
- **Sports Fields:** The white line marking the boundary of a football field represents its perimeter. The green grass inside that boundary is the field's area.

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EXERCISE

A. Multiple Choice Questions (MCQs)

1. A square has a perimeter of 36 cm. What is its area?
   a) 36 cm² ☐ b) 81 cm² ☐ c) 18 cm² ☐ d) 144 cm² ☐
2. The area of a rectangle is 48 m². If its breadth is 6 m, what is its perimeter?
   a) 28 m ☐ b) 30 m ☐ c) 14 m ☐ d) 48 m ☐
3. A triangle has a base of 14 cm and a height of 10 cm. Its area is:
   a) 140 cm² ☐ b) 24 cm² ☐ c) 70 cm² ☐ d) 35 cm² ☐
4. To find the length of ribbon needed to go around a cake, you need to calculate its:
   a) Area ☐ b) Volume ☐ c) Perimeter ☐ d) Weight ☐
5. How many square tiles of side 10 cm are needed for a square floor of side 100 cm?
   a) 10 ☐ b) 100 ☐ c) 1000 ☐ d) 1 ☐

Assertion & Reason

Instructions: In the following questions, a statement of Assertion (A) is given, followed by a corresponding statement of Reason (R). Choose the correct option.

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.

1. **Assertion (A):** If the side of a square is doubled, its perimeter also doubles.
   Reason (R): The perimeter of a square is directly proportional to its side length (P = 4s).

2. **Assertion (A):** A rectangle with length 8 cm and breadth 2 cm has the same area as a square of side 4 cm.
   Reason (R): Two shapes with the same area must also have the same perimeter.

3. **Assertion (A):** The area of a triangle with base 10 cm and height 6 cm is 30 cm^2.
   Reason (R): The area of a triangle is calculated as Base × Height.

Case Study

The Sharma family is re-doing their living room, which is 7 meters long and 5 meters wide. They want to tile the floor with square tiles of side 50 cm. They also want to put a new wooden skirting board around the room, but they need to leave a 1-meter gap for the doorway.

1. What is the area of the living room floor?
2. What is the area of a single tile in square meters?
3. How many tiles will they need to buy?
4. What is the length of the wooden skirting board they need?
5. If tiles cost ₹40 each and the skirting board costs ₹120 per meter, what is the total cost?

Project

My Dream Bedroom Makeover

- **Objective:** To apply your knowledge of perimeter and area to plan and budget for a bedroom makeover.
- **Task:** You have been given a budget of ₹10,000 to redecorate your bedroom. Your bedroom is a rectangle with a length of 5 meters and a breadth of 4 meters. There is one door (1m wide) and one window (2m wide).
- **Part 1: The Floor Plan (Area)**
  1. **Painting the Walls:** You want to paint the four walls. The height of the room is 3 meters. Calculate the total area of the four walls. Remember to subtract the area of the door (1m × 2m) and the window (2m × 1.5m).
  2. **Carpeting the Floor:** You want to lay a new carpet that covers the entire floor. Calculate the area of the floor.

- **Part 2: The Finishing Touches (Perimeter)**
  1. **Skirting Board:** You need to add a wooden skirting board along the base of the walls. Calculate the total length of the board needed (remember to exclude the doorway).
  2. **Fairy Lights:** You want to hang a string of fairy lights along the top edge of all four walls. What is the total length of lights you need?
- **Part 3: The Budget Use the following price list to calculate your total expenses.**
  - **Paint:** ₹200 per square meter (includes labour)
  - **Carpet:** ₹350 per square meter
  - **Skirting Board:** ₹80 per meter
  - **Fairy Lights:** ₹50 per meter
- **Final Report:** Create a short report with a title "**My Dream Bedroom Makeover Plan**". Include:
  - A simple drawing of your room's layout.
  - All your calculations for area and perimeter, clearly labeled.
  - A budget table showing the cost of each item and the total cost.
  - A concluding sentence stating whether you stayed within your ₹10,000 budget.

Source-Based Question

Cricket Pitch Dimensions: All The Facts And Figures

From the complex rules to the strict regulations, cricket is a sport that requires a great deal of knowledge and has us asking a lot of questions to keep up with it. One of the most common questions asked about cricket is: what are the dimensions of a cricket pitch?

Cricket looks simple, but its pitch has very specific dimensions.

We've put together a handy guide to get you up to speed with cricket pitches, from the bowling crease to middle stumps. So, let's dive in!

Cricket Pitch Element	Measurement
Cricket Pitch Turf	20.12 metres long x 3.05 metres wide
Bowling Crease	2.64 metres long
Popping Crease	1.83 metres long on either side (1.22 metres from the bowling crease)
Return Crease	1.32 metres long on either side (2.44 metres behind the popping crease)
Wickets	Tops of cricket stumps should be 71.12 cm from the pitch's ground. Wooden bails shouldn't be any more than 1.27cm above the stumps.

What is the Standard Size of a Cricket Pitch?

A standard cricket pitch is 20.12 m long and 3.05 m wide. It is a central strip with stumps at each end and creases marked around them. Turf pitches are most common, though artificial ones are also used. Umpires check the pitch condition before play.

Non-turf Cricket Pitch Size

Non-turf cricket pitches can be used to play professional and amateur games of cricket, but Lords require different pitch measurements for these surfaces. The standard measurements for a non-turf cricket pitch are 17.68m long by 1.83m wide. This is significantly shorter than a standard turf pitch, which alters the way bowlers have to approach the game.

What are the Different Parts of a Cricket Pitch?

- **Bowling Crease** – 2.64 m line where the bowler delivers. Crossing it = no-ball.
- **Popping Crease** – 1.22 m in front of the bowling crease, at least 1.83 m each side. Batsmen must stay behind it.
- **Return Crease** – 1.32 m each side, 2.44 m behind popping crease. Stepping outside = no-ball.
- **Wickets** – Three stumps (71.12 cm tall) with two bails (≤1.27 cm).

Are Cricket Pitch Dimensions Always the Same?

Yes, dimensions stay the same worldwide for fairness. Surfaces may vary (turf, non-turf, artificial), but measurements don't.

Junior Cricket Pitch

Age Group	Dimensions according to ECB
Under 7s	16 yards (14.6 metres)
Under 9s	18 yards (16.5 metres)
Under 10s	19 yards (17.4 metres)
Under 11s	20 yards (18.3 metres)

Women's Cricket Pitch

Category	Details
Pitch Size	Same as men's (20.12 m × 3.05 m)
Boundary Size	50–64 m

Summary: The Essential Cricket Pitch Dimensions

Knowing the creases, wickets, and exact measurements helps understand the game better. Next time you watch cricket, remember the pitch is more than just a rectangle—it shapes every play.

Source Text: **Adapted from "A Comprehensive Guide to Cricket Pitch Dimensions" by Huck Nets (March 2023).**

Questions on the Data

1. Determine the perimeter of Cricket pitch turf?
2. Whose area is greater U10s or U11s? Use standard width of the pitch 3.05 m.
3. Always a set has 3 stumps placed side by side. If we join the tops of 3 stumps with a string, what is the perimeter of that triangular figure (approx, assuming each gap = 10 cm)?
4. How much shorter in perimeter is U9s pitch compared to the standard pitch? Use standard width of the pitch 3.05 m.

Mind Map

Perimeter and Area

Introduction to Perimeter and Area
- What is perimeter?
- What is area?

Perimeter of Rectangle
- Formula:

  Perimeter = 2 × (Length + Breadth)

Perimeter of Square
- Formula:

  Perimeter = 4 × Side

Perimeter of Triangle
- Formula:

  Perimeter = Sum of all sides

Perimeter of a Regular Polygon
- Formula:

  Perimeter = Number of sides × Length of one side

Area
- Meaning of area (space occupied)
- Standard units: cm^2, m^2, km^2

Area of a Square
- Formula:

  Area = Side × Side

Area of a Rectangle
- Formula:

  Area = Length × Breadth

Area of a Triangle
- Formula:

  Area = $\frac{1}{2}$ × Base × Height