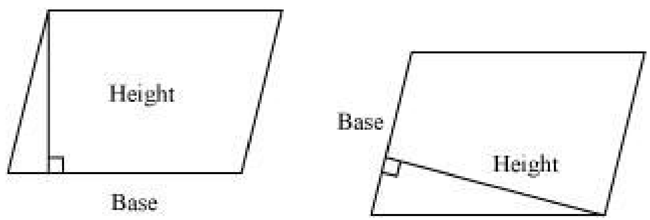
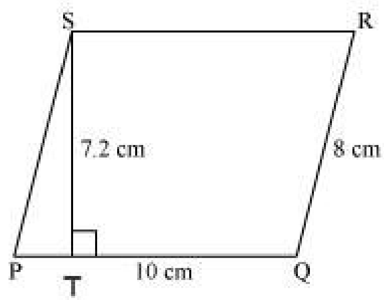
15. Area

- Area of a parallelogram:
  - The perpendicular dropped on a side from its opposite vertex is known as the height and the side is known as the base.
  - Area of a parallelogram = Base × Height



Example:
Find the height of the parallelogram PQRS corresponding to the base RQ.



Solution:
Let the height corresponding to the base RQ be x cm.
Area of the parallelogram PQRS = PQ × ST
= 10 cm × 7.2 cm
= 72 cm^2
Area of the parallelogram = RQ × x
= 8 cm × x cm
= $8x$ cm^2
$\therefore 8x = 72$
$\Rightarrow x = 9$
Thus, the height of the parallelogram corresponding to the base RQ is 9 cm.

- Area of rhombus $= \frac{1}{2}$ (Product of its diagonals)

- Area and perimeter of various shapes:

Shape	Area	Perimeter
1. Rectangle with adjacent sides a and b	$a \times b$	$2(a + b)$

2. Square with side *a*	a^2	$4a$
3. Circle with radius *r*	πr^2	$2\pi r$
4. Triangle with base *b* and its corresponding height *h*	$\frac{1}{2} \times b \times h$	Sum of the three sides
5. Parallelogram with base *b* and its corresponding height *h*	$b \times h$	Sum of the four sides

Area of trapezium = $\frac{1}{2}$ (Sum of the lengths of the parallel sides) × (Perpendicular distance between them)

- **Area of triangle using Heron's formula:**

When all the three sides of a triangle are given, its area can be calculated using Heron's formula, which is given by:

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

Here, *s* is the semi-perimeter of the triangle and is given by, $s = \frac{a+b+c}{2}$

Example:
Find the area of a triangle whose sides are 9 cm, 28 cm and 35 cm.
Solution:
Let a = 9 cm, b = 28 cm and c = 35 cm

Semi-perimeter, $s = \frac{a+b+c}{2} = \frac{9+28+35}{2}\text{ cm} = 36\text{ cm}$

Area of triangle = $\sqrt{36(36-9)(36-28)(36-35)}\text{ cm}^2$

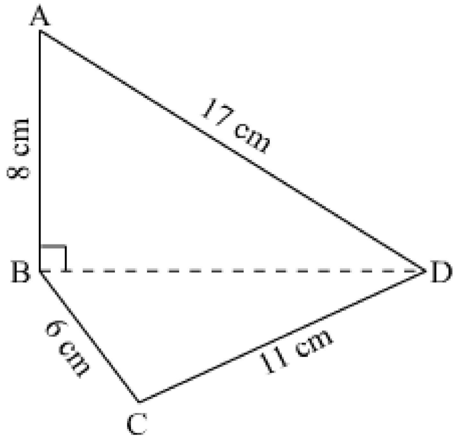
$= \sqrt{36 \times 27 \times 8 \times 1}\text{ cm}^2$

$= 36\sqrt{6}\text{ cm}^2$

- **Area of quadrilaterals using Heron's formula:**

Area of a quadrilateral can also be calculated using Heron's formula. In this, the quadrilateral is divided into two triangles and then the area of each triangle is calculated using Heron's formula.

Example:
What is the area of the given quadrilateral?



Solution:
ΔABD is a right-angled triangle.
Using Pythagoras Theorem, we get
$BD = \sqrt{(AD)^2 - (AB)^2} = \left(\sqrt{(17)^2 - (8)^2}\right)\text{cm} = 15 \text{ cm}$

Area (ΔABD) $= \frac{1}{2} \times \text{Base} \times \text{Height} = \frac{1}{2} \times 15 \times 8 = 60 \text{ cm}^2$
For ΔBCD, let a = 6 cm, b = 11 cm and c = 15 cm
Semi-perimeter, $s = \frac{a+b+c}{2} = \left(\frac{6+11+15}{2}\right)\text{cm} = 16 \text{ cm}$
Area (ΔBCD) = $\sqrt{s(s-a)(s-b)(s-c)}$
$= \sqrt{16(16-6)(16-11)(16-15)} \text{ cm}^2$
$= \sqrt{16 \times 10 \times 5 \times 1} \text{ cm}^2$
$= 20\sqrt{2} \text{ cm}^2$
Area of quadrilateral ABCD $= \left(60 + 20\sqrt{2}\right)\text{cm}^2 = 20\left(3 + \sqrt{2}\right) \text{cm}^2$

- The distance around a circular region is known as its circumference.
- The circumference of a circle = π × Diameter = 2π × Radius

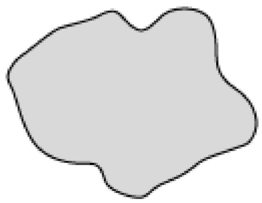
  The value of pi (π) is $\frac{22}{7}$ or 3.14.

- Area of a circle = π × (Radius)^2

  Example: What is the area of a circle whose circumference is 44 cm? $\left(\pi = \frac{22}{7}\right)$

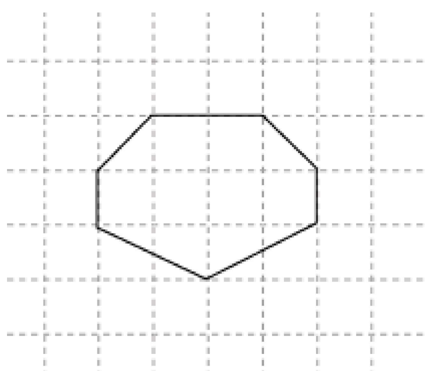
  Solution:
  Circumference = $2\pi r$ = 44 cm
  $\Rightarrow 2 \times \frac{22}{7} \times r = 44 \text{ cm}$
  $\Rightarrow r = 44 \times \frac{7}{22 \times 2} = 7 \text{ cm}$
  $\therefore$ Area of the circle $= \pi r^2 = \frac{22}{7} \times 7 \times 7 = 154 \text{ cm}^2$

- The region enclosed by a closed figure is called its **area.**



- Units of area are square cm, square m etc.
- The concept of area is widely used in our daily life. For example, to find the area of the carpet required to cover the floor, etc.
- We can estimate the area of a surface by drawing it on a square graph paper, where every square measures 1 cm × 1 cm. For this, we have to adopt the following conventions.
    - The area of 1 full square is taken as 1 square unit.
    - The area of a region which is more than half the square is taken as 1 square unit.
    - The area of half the square is taken as $\frac{1}{2}$ square unit.
    - We have to ignore the portions of area that are less than half a square.

Example: Find the area of the following figure.



Solution: We can represent the number of full-filled squares, half filled squares etc. in a tabular form as follows:

Area covered	Number	Area estimate (square unit)
Full-filled squares	6	6
Half-filled squares	2	$\frac{1}{2} \times 2 = 1$
More than half-filled squares	2	2
Less than half-filled squares	2	0

∴ Total area = (6 + 1 + 2) square units = 9 square units