Mensuration: Basic Concepts and Important Formulas

Equilateral Triangle: All the three sides are equal and each angle is equal to 60°.

Area = $\frac{\sqrt{3}}{4}(side)^2$

Height (Altitude) = $\frac{\sqrt{3}}{2}side$

Perimeter = 3(side)

Isosceles Triangle: Two sides and two angles are equal and altitude drawn on non-equal side bisects it.

Area = $\frac{b}{4}\sqrt{4a^2 - b^2}$

Height (Altitude) = $\frac{1}{2}\sqrt{4a^2 - b^2}$

Perimeter = $2a + b$

Where a is the equal side and b is the non-equal side.

Scalene Triangle: It has three unequal sides.

Area = $\sqrt{s(s-a)(s-b)(s-c)}$ {Hero's Formula} where $s = \frac{a+b+c}{2}$ where a, b, c are the sides of the triangle and s is the semi-perimeter.

Perimeter = $a + b + c$

Right Angled Triangle: It is a triangle with on angle is equal to 90°.

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

Perimeter = $p + b + h$

Pythagoras Theorm: $h^2 = p^2 + b^2$ where p = perpendicular, b = base and h = hypotenuse.

Isosceles Right Angled Triangle: It is a triangle with on angle is equal to 90° and two sides containing the right angle are equal.

Area = $\frac{1}{2} \times a^2$

Perimeter = $2a + d$ where a = sides containing the right angle, d = hypotenuse.

Properties of Triangles:

1) Side opposite to the greatest angle will be the greatest and side opposite to the smallest angle will be the smallest.

2) Among all the triangles that can be formed with a given perimeter, the equilateral triangle will have the maximum area.

3) The point where the three medians of a triangle meet is called the centroid. Centroid divides the median in the ratio 2:1.

4) The median of a triangle divides it into two triangles of equal areas.

5) Inradius of an equilateral triangle of side 'a' is $\frac{a}{2\sqrt{3}}$

6) Circumradius of an equilateral triangle of side 'a' is $\frac{a}{\sqrt{3}}$

7) Area of a triangle formed by joining the mid-points of the sides of a given triangle is 1/4th of the area of the given triangle.

Quadrilateral:

Square: A parallelogram in which all the sides are equal and perpendicular to each other, is called a square.

Area = $(side)^2$

Diagonal = $\sqrt{2}\ (side)$

Perimeter = 4(side)

Properties of a Square:

1) Diagonals of a square are equal and bisect each other at right angles.

2) All square are rhombus but vice-versa is not true.

3) If areas of two squares are in the ratio $A_1 : A_2$ then the ratio of their perimeter is $\sqrt{A_1} : \sqrt{A_2}$

Rectangle: A parallelogram in which opposite sides are equal and each angle is equal to 90°.

Area = $Length \times Breadth = L \times B$

Perimeter = $2(L + B)$

Diagonal = $\sqrt{L^2 + B^2}$

Properties of a Rectangle:

1) Diagonals of a rectangle are of equal length and they bisect each other.

2) All rectangle are parallelogram but vice-versa is not true.

Parallelogram: A quadrilateral in which opposite sides are parallel and equal, is called a parallelogram.

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Area = $Base \times Height = b \times h$

Perimeter = $2(a + b)$

h = height, b = base, a = other side.

Properties of a Parallelogram:

1) Opposite angles are equal in a parallelogram but they are not right angles.

2) Diagonals of a parallelogram bisect each other.

3) Diagonals of a parallelogram divides it into two triangles of equal area.

4) A parallelogram inscribed in a circle is a rectangle.

5) A parallelogram circumscribed about a circle is a rhombus.

6) A parallelogram and a rectangle have same areas if they are on the same base and between the same parallel lines.

7) Opposite angles of a parallelogram are equal.

8) Sum of the squares of the four sides is equal to the sum of the squares of the diagonals.

Trapezium: It is a quadrilateral where only one pair of opposite sides are parallel.

Area = $\frac{1}{2} \times (Sum\ of\ parallel\ sides) \times Height = \frac{1}{2} \times (a + b) \times h$ where a, b are parallel sides and h is the distance between parallel sides.

Perimeter = $AB + BC + CD + AD$

Area of a trapezium when the lengths of parallel and non-parallel sides are given = $\frac{a+b}{k}\sqrt{s(s-k)(s-c)(s-d)}$ where $k = a - b$ and $s = \frac{k+c+d}{2}$

Perpendicular distance 'h' between two parallel sides = $\frac{2}{k}\sqrt{s(s-k)(s-c)(s-d)}$ where $k = a - b$ and $s = \frac{k+c+d}{2}$

Rhombus: A parallelogram in which all the sides are equal. The opposite angles in a rhombus are equal but they are not right angles.

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

Perimeter = $4a$

$a = \frac{1}{2} \times \sqrt{{d_1}^2 + {d_2}^2}$ Where a = side, d_1 and d_2 are diagonals.

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Properties of rhombus:

1) Diagonals of a rhombus are unequal and they bisect each other at right angles.

2) All rhombus are parallelogram but vice-versa is not true.

3) A rhombus may or may not be a square but all squares are rhombus.

Circle: Let r be radius of the circle.

Area = πr^2

Circumference (perimeter) = $2\pi r$

Diameter = $2r$

Area of a sector of central angle $(\theta) = \frac{\theta}{360}\ \pi r^2$

Semi-circle: Let r be radius of the semi-circle

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

Perimeter = $\pi r + 2r$

Circular Ring: Let 'R' be radius of the bigger ring, 'r' be radius of the smaller ring.

Area = $\pi(R^2 - r^2)$

Difference in circumference of both the rings = $2\pi R - 2\pi r = 2\pi(R - r)$

Volumes and Surface Areas

Cube:

Volume = a^3

Lateral Surface Area = $4a^2$

Total Surface Area = $6a^2$

Diagonal = $\sqrt{3}a$ where a is the edge of the cube.

Cuboid:

Volume = lbh

Area of 4 walls of the room = Lateral Surface Area of a cuboid = $2(l + b)h$

Total Surface Area = $2(lb + bh + hl)$

Diagonal = $\sqrt{l^2 + b^2 + h^2}$ where l = length, b = breadth, h = height

Area of the floor or the roof = lb

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Cylinder: Let r be radius of the base, h be the height.

Volume = $\pi r^2 h$

Curved Surface Area = $2\pi rh$

Total Surface Area = $2\pi rh + 2\pi r^2 = 2\pi r(h + r)$

Cone: Let r be radius of the base, h be the height.

Volume = $\frac{1}{3}\pi r^2 h$

Slant height $(l) = \sqrt{r^2 + h^2}$

Curved Surface Area = πrl

Total Surface Area = $\pi rl + \pi r^2 = \pi r(l + r)$

Sphere: Let r be radius of the sphere.

Volume = $\frac{4}{3}\pi r^3$

Total Surface Area = $4\pi r^2$

Hollow Sphere: Let r be internal radius, R be the external radius.

Volume = $\frac{4}{3}\pi(R^3 - r^3)$

Internal Surface Area = $4\pi r^2$

External Surface Area = $4\pi R^2$

Hemisphere: Let r be radius of the hemi-sphere.

Volume = $\frac{2}{3}\pi r^3$

Total Surface Area = $3\pi r^2$

Curved Surface Area = $2\pi r^2$