

COMPLETE GEOMETRY FORMULAS & TRICKS

SSC CGL Master Notes - All Essential Formulas with Memory
Techniques

Points, Lines, Angles, Triangles, Circles, Quadrilaterals & 3D Shapes

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1. BASIC CONCEPTS & ANGLES

Angle Relationships

Complementary Angles

Sum = 90°

$$\angle A + \angle B = 90^\circ$$

Supplementary Angles

Sum = 180°

$$\angle A + \angle B = 180^\circ$$

Adjacent Angles

Share vertex & side

No common interior

Memory Tip: "Complementary" starts with 'C' which comes before 'S' in alphabet, and 90° comes before 180° numerically. Complementary = 90° , Supplementary = 180° .

Parallel Lines & Transversals

- Corresponding angles: Equal
- Alternate interior angles: Equal
- Alternate exterior angles: Equal
- Co-interior angles: Supplementary (sum = 180°)
- Co-exterior angles: Supplementary (sum = 180°)

Quick Trick: When parallel lines are cut by a transversal, all acute angles are equal and all obtuse angles are equal. Each acute + each obtuse = 180° .

2. TRIANGLE FORMULAS

Basic Triangle Properties

- Sum of angles = 180°
- Exterior angle = Sum of opposite interior angles
- Triangle inequality: $a + b > c$, $b + c > a$, $c + a > b$

Area Formulas

Basic Formula

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

Heron's Formula

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

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

Using Trigonometry

$$\text{Area} = \frac{1}{2} ab \sin C$$

$$\text{Area} = \frac{1}{2} bc \sin A$$

$$\text{Area} = \frac{1}{2} ca \sin B$$

Right Triangle Formulas

- Pythagorean Theorem: $a^2 + b^2 = c^2$
- Area = $\frac{1}{2} \times$ product of legs
- Altitude to hypotenuse: $h = ab/c$
- 30-60-90 triangle: sides = $x, x\sqrt{3}, 2x$
- 45-45-90 triangle: sides = $x, x, x\sqrt{2}$

Memory Tip: For 30-60-90 triangle, remember "1, 2, $\sqrt{3}$ " but be careful with placement. The side opposite 30° is smallest, opposite 60° is middle, opposite 90° is largest.

3. TRIANGLE TRICKS & THEOREMS

Similarity Theorems

- **AAA Similarity:** All angles equal
- **SSS Similarity:** All sides proportional
- **SAS Similarity:** One angle equal & sides including it proportional

Quick Trick: In similar triangles, ratio of areas = square of ratio of corresponding sides. If sides ratio = k , then area ratio = k^2 .

Important Triangle Centers

Center	Definition	Property
Centroid	Intersection of medians	Divides median in 2:1 ratio
Circumcenter	Intersection of perpendicular bisectors	Equidistant from vertices
Incenter	Intersection of angle bisectors	Equidistant from sides
Orthocenter	Intersection of altitudes	No fixed ratio

Memory Tip: "Centroid" has 'd' for division (divides medians 2:1). "Circumcenter" has 'circum' for circle (circumcircle). "Incenter" has 'in' for inside (incircle).

Special Line Segments

- **Median:** Joins vertex to midpoint of opposite side
- **Altitude:** Perpendicular from vertex to opposite side
- **Angle Bisector:** Divides angle into two equal parts
- **Perpendicular Bisector:** Right bisector of side

4. CIRCLE FORMULAS

Basic Circle Formulas

Circumference

$$C = 2\pi r = \pi d$$

Area

$$A = \pi r^2$$

Arc Length

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

$$l = r\theta \text{ (}\theta \text{ in radians)}$$

Sector Area

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

$$A = \frac{1}{2} r^2 \theta \text{ (}\theta \text{ in radians)}$$

Circle Segments

- Segment Area = Sector Area - Triangle Area
- For chord length c and radius r :
Distance from center = $\sqrt{r^2 - (c/2)^2}$
- For height h of segment and radius r :
Chord length = $2\sqrt{2rh - h^2}$

5. CIRCLE TRICKS & THEOREMS

Angle Theorems

- Central angle = $2 \times$ Inscribed angle (same arc)
- Angle in semicircle = 90°
- Angles in same segment are equal
- Opposite angles of cyclic quadrilateral are supplementary

Quick Trick: If a triangle is inscribed in a circle and one side is diameter, then angle opposite to diameter is always 90° .

Tangent Theorems

- Tangent is perpendicular to radius at point of contact
- Tangents from external point are equal
- Angle between tangent and chord = angle in alternate segment

Useful Circle Formulas

Concept	Formula
Chord Length	$2\sqrt{(r^2 - d^2)}$ where d = distance from center
Distance between centers of two circles	$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$
Direct Common Tangents	$\sqrt{d^2 - (r_1 - r_2)^2}$
Transverse Common Tangents	$\sqrt{d^2 - (r_1 + r_2)^2}$

6. QUADRILATERALS

Types & Properties

Quadrilateral	Properties	Area Formula
Square	All sides equal, all angles 90°	a^2
Rectangle	Opposite sides equal, all angles 90°	$l \times b$
Parallelogram	Opposite sides parallel and equal	base $\times$ height
Rhombus	All sides equal, opposite angles equal	$\frac{1}{2} \times d_1 \times d_2$
Trapezium	One pair of parallel sides	$\frac{1}{2} \times (\text{sum of parallel sides}) \times \text{height}$

Important Formulas

- Sum of interior angles = 360°
- For cyclic quadrilateral: Opposite angles sum to 180°
- For parallelogram: Diagonals bisect each other
- For rhombus: Diagonals are perpendicular bisectors
- For rectangle: Diagonals are equal

Memory Tip: In parallelogram, remember "BASA" - Both pairs of opposite sides are parallel, Angles supplementary adjacent, Successive angles sum to 180° .

7. POLYGONS

Regular Polygon Formulas

For regular polygon with n sides, side length a :

- Sum of interior angles = $(n-2) \times 180^\circ$
- Each interior angle = $[(n-2) \times 180^\circ]/n$
- Each exterior angle = $360^\circ/n$
- Number of diagonals = $n(n-3)/2$
- Area = $(n \times a^2)/(4 \times \tan(180^\circ/n))$

Special Polygons

Equilateral Triangle

$$\text{Area} = (\sqrt{3}/4) \times a^2$$

$$\text{Height} = (\sqrt{3}/2) \times a$$

Regular Hexagon

$$\text{Area} = (3\sqrt{3}/2) \times a^2$$

Comprises 6 equilateral triangles

Regular Octagon

$$\text{Area} = 2(1+\sqrt{2}) \times a^2$$

$$\text{Interior angle} = 135^\circ$$

Quick Trick: For regular hexagon inscribed in circle, side = radius. This makes calculations much easier!

8. COORDINATE GEOMETRY

Distance & Section Formulas

- Distance between (x_1, y_1) and (x_2, y_2) : $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- Midpoint: $[(x_1 + x_2)/2, (y_1 + y_2)/2]$
- Section formula $(m:n)$: $[(mx_2 + nx_1)/(m+n), (my_2 + ny_1)/(m+n)]$
- Centroid of triangle: $[(x_1 + x_2 + x_3)/3, (y_1 + y_2 + y_3)/3]$

Line Formulas

- Slope $m = (y_2 - y_1)/(x_2 - x_1)$
- Equation: $y = mx + c$ (slope-intercept)
- Equation: $y - y_1 = m(x - x_1)$ (point-slope)
- Distance from point to line $|Ax_1 + By_1 + C|/\sqrt{A^2 + B^2}$
- Angle between lines: $\tan \theta = |(m_1 - m_2)/(1 + m_1 m_2)|$

Area of Triangle

Area = $\frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$
 For vertices $(x_1, y_1), (x_2, y_2), (x_3, y_3)$

Memory Tip: For triangle area formula, remember " $x_1y_2 - x_2y_1 + x_2y_3 - x_3y_2 + x_3y_1 - x_1y_3$ " divided by 2. Use cyclic pattern.

9. MENSURATION (2D & 3D)

3D Shapes - Surface Area & Volume

Shape	Surface Area	Volume
Cube (side a)	$6a^2$	a^3
Cuboid (l,b,h)	$2(lb+bh+hl)$	$l \times b \times h$
Sphere (radius r)	$4\pi r^2$	$(4/3)\pi r^3$
Cylinder (r,h)	$2\pi r(h+r)$	$\pi r^2 h$
Cone (r,h,l)	$\pi r(l+r)$	$(1/3)\pi r^2 h$
Hemisphere (r)	$3\pi r^2$	$(2/3)\pi r^3$

Important 3D Relationships

- Diagonal of cube = $a\sqrt{3}$
- Diagonal of cuboid = $\sqrt{l^2+b^2+h^2}$
- Slant height of cone = $\sqrt{r^2+h^2}$
- For same volume, sphere has least surface area
- For same surface area, sphere has maximum volume

Memory Tip: For cylinder formulas, remember " $2\pi r$ " appears in circumference, curved surface area ($2\pi rh$), and total surface area ($2\pi r(h+r)$). Volume is base area $\times$ height = $\pi r^2 h$.

10. QUICK CALCULATION TRICKS

Percentage Shortcuts

Area Increase/Decrease:

- If side increases by $x\%$, area increases by approximately $2x\%$ (for small x)
- Exact formula: New area = $(100+x)^2/100 \times$ original area

Volume Increase/Decrease:

- If side increases by $x\%$, volume increases by approximately $3x\%$ (for small x)
- Exact formula: New volume = $(100+x)^3/1000 \times$ original volume

Special Right Triangles

- 3-4-5 triangle: Multiple (6-8-10, 9-12-15, etc.)
- 5-12-13 triangle: Another Pythagorean triple
- 7-24-25 triangle: Useful for calculations
- 8-15-17 triangle: Remember these common triples

Memory Tip: Create a story: "3, 4, 5 went to war with 5, 12, 13. 7, 24, 25 and 8, 15, 17 were their allies." Visualize this to remember the triples.

Approximation Tricks

- $\pi \approx 22/7$ (for easy calculations)
- $\sqrt{2} \approx 1.414$, $\sqrt{3} \approx 1.732$, $\sqrt{5} \approx 2.236$
- For circle area: Radius² $\times$ 3.14 (use 3.14 instead of π)
- For mental math: Multiply radius by itself, then by 3, then add $0.14 \times \text{radius}^2$

Exam Strategy

Time-Saving Tips:

1. Memorize common Pythagorean triples
2. Learn square numbers up to 30^2
3. Remember π values: $\pi \approx 3.14$, $\pi \approx 22/7$, $\pi \approx 3.1416$
4. Use elimination method in MCQs
5. For complex shapes, break into simpler parts

6. Check units and dimensions in answers
7. Verify if answer seems reasonable

Final Revision Tip: Create flashcards with formulas on one side and examples on the other. Practice daily for 15 minutes. Focus on understanding concepts rather than rote memorization. For SSC CGL, pay special attention to triangles, circles, and mensuration as they carry maximum weightage.

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Practice regularly and master these formulas for success in the quantitative aptitude section.