

① CARTESIAN PLANE BASICS

Origin = (0, 0)

Point form: (x, y) — x first, then y

x-axis: y = 0 **y-axis:** x = 0

Notation: Points = CAPITAL letters; Lines = lower case

★ *LEFT/RIGHT for x first, then UP/DOWN for y*

② MIDPOINT & DISTANCE

Midpoint of (x₁, y₁) and (x₂, y₂):

$$M = ((x_1+x_2)/2, (y_1+y_2)/2)$$

Distance |AB|: (in tables)

$$|AB| = \sqrt{[(x_2-x_1)^2 + (y_2-y_1)^2]}$$

✓ **TIP:** If P is midpoint of A and B, B is reflection of A through P (central symmetry)

③ SLOPE

Also called: gradient, incline, rate of change

4 ways to find slope:

- m = rise / run
- m = (y₂ - y₁) / (x₂ - x₁)
- m = tan θ (angle with positive x-axis)
- Line ax + by + c = 0 → m = -a/b
- Line y = mx + c → m = number before x

★ *Positive slope: rises right. Negative: falls right.*

④ PARALLEL & PERPENDICULAR

Parallel: same slope m₁ = m₂

Perpendicular: invert & change sign m₁ · m₂ = -1

Quick form (parallel to ax+by=c):

$$ax + by = d$$

Quick form (perpendicular to ax+by=c):

$$bx - ay = d \quad (\text{swap, change sign})$$

⑤ EQUATION OF A LINE

Need a point AND a slope:

$$y - y_1 = m(x - x_1)$$

Or use: y = mx + c

Given 2 points: find slope first, then equation

Drawing a line:

- x-axis cut: let y = 0
- y-axis cut: let x = 0

Two lines meet: simultaneous equations

Point on line: just sub it in

⑥ AREA OF A TRIANGLE

If one vertex is (0,0):

$$\text{Area} = \frac{1}{2} |x_1 y_2 - x_2 y_1|$$

If no vertex at origin:

Translate to put one vertex at (0,0)

⚠ **WATCH:** Always include SQUARE units!

Collinear: 3+ points on same line

→ slope of AB = slope of BC

⑦ ANGLE BETWEEN 2 LINES

Formula in tables: uses slopes m₁, m₂

$$\tan \theta = |(m_1 - m_2) / (1 + m_1 m_2)|$$

Tan(acute) > 0 Tan(obtuse) < 0

Lines through point P at angle θ to a given line:

→ get 2 values of m, hence 2 lines

★ *Find ONE line first — the second appears in the process*

⑧ PERPENDICULAR DISTANCE

Distance from (x₁, y₁) to ax + by + c = 0:

$$d = |ax_1 + by_1 + c| / \sqrt{a^2 + b^2} \quad (\text{in tables})$$

This is the SHORTEST distance from point to line

If LHS = |-10|/√13 → point on the negative side of the line

Distance between 2 parallel lines:

Pick a point on one, find distance to the other

Divisors: use ratio formula or section formula

⑨ TRIANGLE CENTRES

Centroid: balancing point — meet of medians

$$\text{Centroid} = ((x_1+x_2+x_3)/3, (y_1+y_2+y_3)/3)$$

Circumcentre: equidistant from all 3 vertices

→ Intersection of perpendicular bisectors ("mediators")

→ Right-angle triangle: midpoint of HYPOTENUSE

Orthocentre: intersection of ALTITUDES

Altitude = line ⊥ to a side, through opposite vertex

★ *Centroid 1/3-1/3, Circumcentre ⊥ bisectors, Orthocentre altitudes*

⑩ FINDING CENTRES — METHOD

CIRCUMCENTRE:

1. Midpoint of side BC (call it D)
2. Slope BC → perpendicular slope
3. Equation of perp bisector through D
4. Repeat for another side
5. Solve simultaneously

ORTHOCENTRE:

1. Slope BC → perpendicular slope
2. Use perp slope + opposite vertex A
3. Repeat with another side, solve simultaneously