Cambridge IGCSE · Mathematics 0580 · Notes

Coordinate geometry

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Read first: **Equations and changing the subject**

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What you need to know

By the end of this topic you should be able to:

1. **Use coordinates.** Read and plot points (x, y) in all four quarters of a grid, including negative values, and use coordinates to describe points of shapes.
2. **Draw straight-line graphs** from their equations, such as $y = -2x + 5$, or from a table of values. **Extended only:** also from equations in other forms, such as $y = 7 - 4x$ or $3x + 2y = 5$.
3. **Find the gradient of a straight line** drawn on a grid. **Extended only:** also calculate it from the coordinates of two points on the line.
4. **Extended only: find the length of a line segment and the coordinates of its midpoint** from the coordinates of its ends.
5. **Find and use the equation of a straight line.** Work out $y = mx + c$ from a graph (or, Extended, from two points), read the gradient and y-intercept from an equation, and know that $x = k$ and $y = k$ are vertical and horizontal lines. **Extended only:** also work with $ax + by = c$, for example find the gradient and y-intercept of $2x + 5y = 10$. Give every equation fully simplified.
6. **Parallel lines:** find the gradient and equation of a line parallel to a given line.
7. **Extended only: perpendicular lines:** find the gradient and equation of a line perpendicular to a given line, including the perpendicular bisector of a line segment.

Understand it

Coordinates

A point is written (x, y): first how far **across** from the origin O, then how far **up**. Negative x is to the left of the y-axis and negative y is below the x-axis. So $(-3, 2)$ is 3 left and 2 up, and $(2, -3)$ is 2 right and 3 down: the order matters.

Every point on the y-axis has $x = 0$, and every point on the x-axis has $y = 0$. Before reading a point, check the scale: one small square is not always one unit.

Drawing a straight line

An equation such as $y = 2x - 1$ is a rule linking x and y; every point that fits the rule lies on one straight line. To draw it:

1. choose three x-values across the range asked for, such as $x = -2, 0, 3$;
2. work out y for each: $-5, -1, 5$;
3. plot the points and join them with **one ruled line** across the whole range. The third point is a check: if the three are not in a line, one of them is wrong.

Extended only: for $ax + by = c$, the two easiest points are where the line crosses the axes. For $2x + 5y = 10$: put $x = 0$ to get $y = 2$, and put $y = 0$ to get $x = 5$. Plot $(0, 2)$ and $(5, 0)$ and join them.

Special lines:

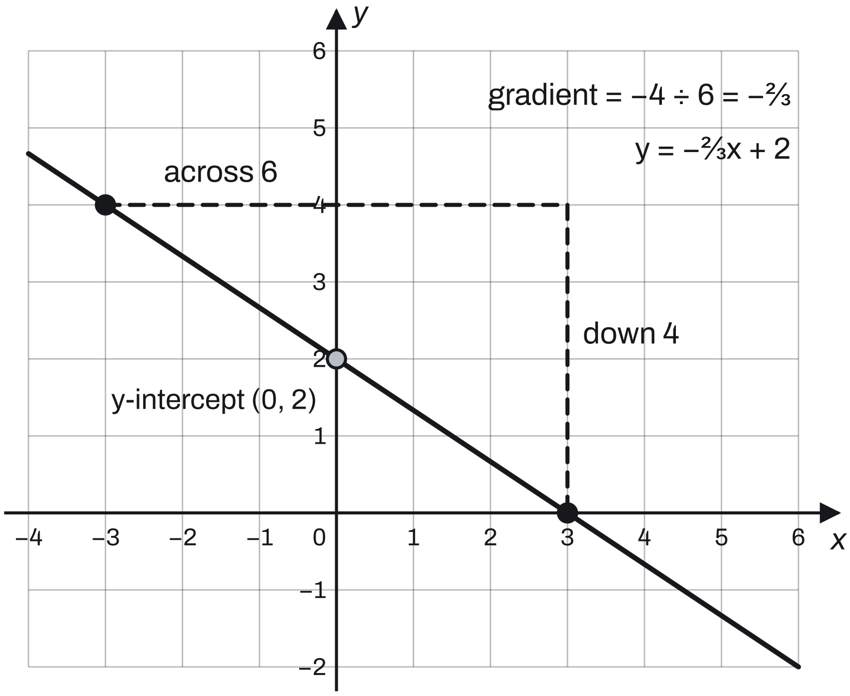
- $x = k$ is the **vertical** line through k on the x-axis (every point has x-coordinate k). The y-axis itself is $x = 0$.
- $y = k$ is the **horizontal** line through k on the y-axis. The x-axis is $y = 0$.
- $y = x$ goes through the origin at 45° up to the right; $y = -x$ goes through the origin at 45° down to the right.

Gradient

The **gradient** is how steep a line is: how far it goes up for each 1 across.

$$\text{gradient} = \frac{\text{change in } y}{\text{change in } x} = \frac{\text{rise}}{\text{run}}$$

From a grid, pick two points where the line crosses exact grid corners, as far apart as you can. Draw a right-angled triangle under (or over) the line and count the squares **using the axis scales**. If the line goes **up** from left to right the gradient is **positive**; if it goes **down** it is **negative**.



A horizontal line has gradient 0. A vertical line has no gradient (you cannot divide by a run of 0).

Extended only: from two points (x_1, y_1) and (x_2, y_2),

$$m = \frac{y_2 - y_1}{x_2 - x_1}.$$

For $(-1, 3)$ and $(5, -6)$: $m = \dfrac{-6-3}{5-(-1)} = \dfrac{-9}{6} = -\dfrac{3}{2}$. Keep the same order on top and bottom (second point minus first point in both), and the sign looks after itself.

The equation $y = mx + c$

In $y = mx + c$, the number in front of x is the **gradient** m, and c is the y**-intercept**, where the line crosses the y-axis at $(0, c)$. So $y = 4x - 3$ has gradient 4 and crosses the y-axis at $(0, -3)$, and $y = 7 - 2x$ is $y = -2x + 7$: gradient -2, y-intercept 7.

To **find** the equation of a line, you need m and c:

- from a graph, read c where the line crosses the y-axis and work out m with a triangle, as in the diagram above: $y = -\frac{2}{3}x + 2$;
- if you know m and one point on the line, substitute the point into $y = mx + c$ and solve for c. For $m = 3$ through $(2, 1)$: $1 = 3 \times 2 + c$, so $c = -5$ and the line is $y = 3x - 5$.

Extended only: an equation in another form must be rearranged to $y = \ldots$ **before** you read the gradient. $3x + 4y = 20$ gives $4y = -3x + 20$, so $y = -\frac{3}{4}x + 5$: gradient $-\frac{3}{4}$ (not 3), y-intercept 5.

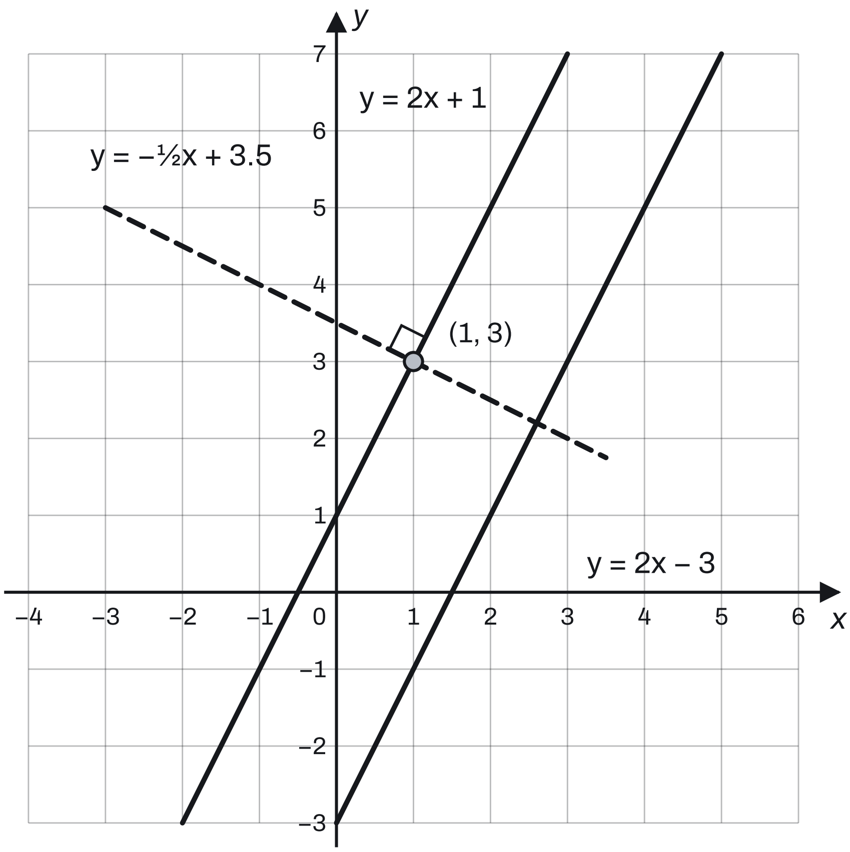
Parallel and perpendicular lines

Parallel lines go in the same direction, so they have the **same gradient**. $y = 2x + 1$ and $y = 2x - 3$ are parallel; only the y-intercept is different.

Extended only: two lines are **perpendicular** (at right angles) when their gradients multiply to -1:

$$m_1 \times m_2 = -1, \qquad \text{so} \qquad m_2 = -\frac{1}{m_1}.$$

In words: turn the gradient upside down and change its sign (the **negative reciprocal**). $2 \to -\frac{1}{2}$, $-\frac{2}{3} \to \frac{3}{2}$, $\frac{1}{4} \to -4$, $-5 \to \frac{1}{5}$.



Why it works: turning a line through 90° swaps its "across" and "up" and makes one of them negative. A line going 1 across and 2 up becomes one going 2 across and 1 down, so gradient 2 becomes $-\frac{1}{2}$.

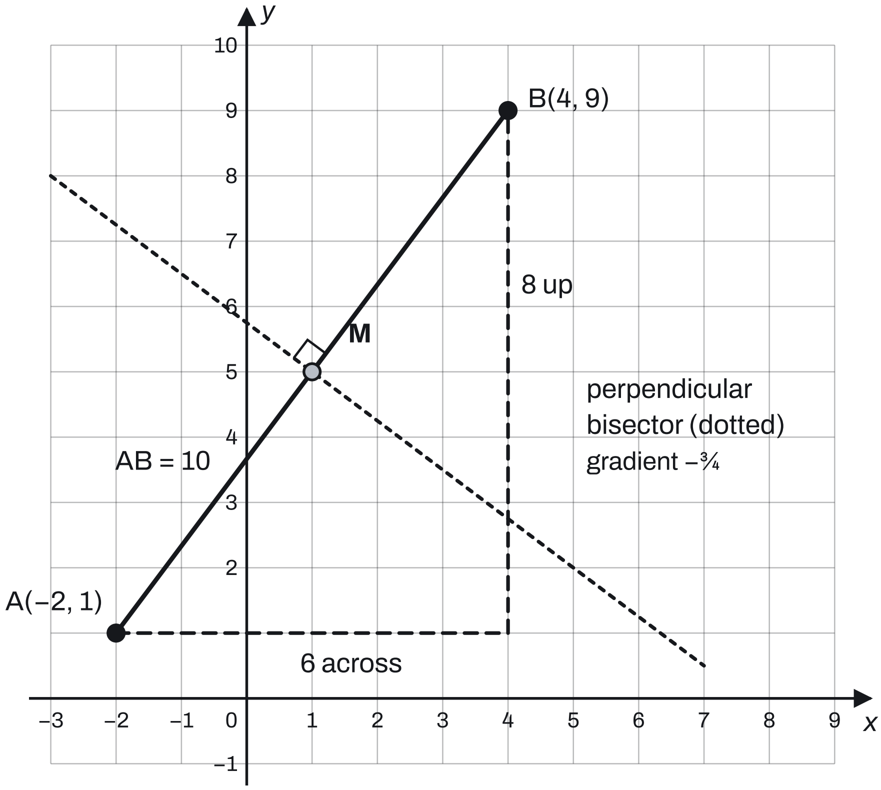
Length and midpoint

Extended only. The **midpoint** of a line segment is halfway along it, so its coordinates are the averages of the ends:

$$M = \left(\frac{x_1 + x_2}{2}, \ \frac{y_1 + y_2}{2}\right).$$

The **length** comes from Pythagoras: the line is the longest side of a right-angled triangle whose other sides are the change in x and the change in y.

$$\text{length} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$



For $A(-2,1)$ and $B(4,9)$: $M = \left(\frac{-2+4}{2}, \frac{1+9}{2}\right) = (1,5)$ and $AB = \sqrt{6^2+8^2} = \sqrt{100} = 10.$

The **perpendicular bisector** of AB cuts AB in half at right angles. It goes **through the midpoint** and has the **perpendicular gradient**. Here AB has gradient $\frac{8}{6} = \frac{4}{3}$, so the bisector has gradient $-\frac{3}{4}$. Substituting $M(1,5)$: $5 = -\frac{3}{4} \times 1 + c$, so $c = \frac{23}{4}$, and the bisector is $y = -\frac{3}{4}x + \frac{23}{4}$. Every point on it is the same distance from A as from B.

Where lines cross

- A line crosses the y**-axis** where $x = 0$, and the x**-axis** where $y = 0$. For $y = 3x - 6$: the y-axis at $(0, -6)$, the x-axis where $0 = 3x - 6$, at $(2, 0)$.
- Two lines cross where both equations are true at once. On a graph, read the point where the lines meet. By algebra, set the two expressions for y equal: $y = x + 4$ and $y = 10 - 2x$ give $x + 4 = 10 - 2x$, so $x = 2$ and $y = 6$: the point $(2, 6)$.
- A point lies on a line if its coordinates fit the equation. Is $(3, 5)$ on $y = 2x - 1$? $2 \times 3 - 1 = 5$, so yes.

Key facts and formulas

"Given" means it is on the List of formulas printed in the exam paper. Nothing in this topic is on that list, so learn all of these.

Formula	Status
Point (x, y): x across, then y up	Learn it
Straight line $y = mx + c$: gradient m, y-intercept $(0, c)$	Learn it
Gradient $= \dfrac{\text{change in } y}{\text{change in } x}$; up to the right is positive, down to the right is negative	Learn it
Extended only: gradient through (x_1, y_1) and (x_2, y_2): $m = \dfrac{y_2 - y_1}{x_2 - x_1}$	Learn it
$x = k$ is vertical; $y = k$ is horizontal (gradient 0)	Learn it
Parallel lines have equal gradients	Learn it
Extended only: perpendicular lines: $m_1 \times m_2 = -1$, so $m_2 = -\dfrac{1}{m_1}$	Learn it
Extended only: midpoint $= \left(\dfrac{x_1 + x_2}{2}, \dfrac{y_1 + y_2}{2}\right)$	Learn it
Extended only: length $= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$	Learn it
Line through (x_1, y_1) with gradient m: substitute into $y = mx + c$ to find c (or use $y - y_1 = m(x - x_1)$)	Learn it
Crossing the y-axis: put $x = 0$; crossing the x-axis: put $y = 0$	Learn it

How to do it

In the questions we have tagged for this topic (71 questions, 2021–2025; one of them was printed on two papers), the types came up this often. 35 of the 71 questions have parts of more than one type, so the counts add up to more than 71.

Question type	Questions
Equation of a line from a graph or two points	31
Perpendicular lines and perpendicular bisectors	25
Gradient and y-intercept from an equation; parallel lines	17
Midpoint and length of a line segment	16
Reading, plotting and working out coordinates	16

Question type	Questions
Where a line crosses an axis or another line	14
Drawing and recognising straight-line graphs	9

1. Equation of a line from a graph or two points (31 questions)

From a line drawn on a grid:

1. **Read** c, where the line crosses the y-axis. If it crosses between grid lines, use another method for c (step 4).
2. **Choose two points** on the line at exact grid corners, far apart.
3. **Gradient** $=$ rise $\div$ run, counted with the axis scales, with a minus sign if the line goes down to the right. Simplify the fraction.
4. **Write** $y = mx + c$ with both numbers in. If c was not clear, substitute one of your points to find it.

Extended only, from two points such as $(-1, 7)$ and $(3, -5)$:

1. $m = \dfrac{-5-7}{3-(-1)} = \dfrac{-12}{4} = -3$.
2. Substitute either point: $7 = -3 \times (-1) + c$, so $c = 4$.
3. $y = -3x + 4$. Check with the other point: $-3 \times 3 + 4 = -5$. ✓

Variations you will meet:

- **"Find the gradient" only**, from a grid or two points: stop after the gradient.
- **A horizontal line** through $(0, 4)$ is $y = 4$ ("parallel to the x-axis"); a vertical line through $(6, 0)$ is $x = 6$.
- **A line through the origin** has $c = 0$: $y = mx$.
- **Unknown coordinates.** If the gradient is known, the gradient formula gives an equation. A line through $(a, 5)$ and $(b, 17)$ with gradient 4: $\dfrac{17-5}{b-a} = 4$, so $b - a = 3$ and $a = b - 3$.
- **Rearranging** the answer: "make x the subject of $y = mx + c$" gives $x = \dfrac{y-c}{m}$.

2. Perpendicular lines and perpendicular bisectors (25 questions)

Extended only for the calculations. On Core papers you may be asked to **draw** a line through a point at right angles to a line on a grid: use a protractor or the corner of your ruler, or use the gradient idea (a line going 1 across and 2 up turns into one going 2 across and 1 down).

Perpendicular line through a point:

1. Find the gradient of the given line (rearrange to $y = \ldots$ first if needed).
2. Perpendicular gradient $= -\dfrac{1}{m}$.
3. Substitute the given point into $y = mx + c$ to find c, and write the equation.

Perpendicular bisector of AB:

1. **Midpoint** M of AB.
2. **Gradient of** AB, then the **perpendicular gradient**.
3. Substitute M (not A or B) to find c.
4. Write $y = mx + c$, or the form asked for.

For $A(8,1)$ and $B(2,5)$: $M = (5,3)$; gradient $AB = \dfrac{5-1}{2-8} = -\dfrac{2}{3}$; perpendicular gradient $\dfrac{3}{2}$; $3 = \dfrac{3}{2} \times 5 + c$, so $c = -\dfrac{9}{2}$, and the bisector is $y = \dfrac{3}{2}x - \dfrac{9}{2}$ (or $y = 1.5x - 4.5$).

Variations you will meet:

- **"Find the gradient of a line perpendicular to** $4y = 3x + 2$**"**: rearrange first, $y = \frac{3}{4}x + \frac{1}{2}$, so the answer is $-\frac{4}{3}$.
- **"Show that the equation is ..."**: every step must be seen, including the working for the gradient; your last line must match the given equation.
- **Other forms of the answer**, such as $2y + 3x = 14$: multiply by the denominator and collect terms, keeping integers.
- **Shapes.** The diagonals of a kite or a rhombus are perpendicular, and in a kite one diagonal passes through the midpoint of the other; the sides of a square or rectangle meet at right angles. Use these facts to get gradients and points.
- **A point on the bisector**, such as $(2, n)$: substitute $x = 2$ into its equation.
- **Tangent lines** from differentiation: a line perpendicular to a tangent uses the same $-\frac{1}{m}$ rule.

3. Gradient and y-intercept from an equation; parallel lines (17 questions)

1. **Write the equation as** $y = mx + c$ if it is not already. **Extended only:** $5x + 2y = 8$ becomes $y = -\frac{5}{2}x + 4$.
2. **Gradient** $=$ the number in front of x; y**-intercept** $= c$, and the crossing point is $(0, c)$ (give both coordinates when asked for "coordinates").
3. **Parallel line through a point:** keep the same m, substitute the point to find the new c.

For example, parallel to $y = 4x - 1$ through $(-2, 3)$: $3 = 4 \times (-2) + c$, so $c = 11$ and the line is $y = 4x + 11$.

Variations you will meet:

- **"Write down the equation of a line parallel to** $y = 2x$**"**: any $y = 2x + c$ with $c \neq 0$, for example $y = 2x + 1$.
- **Parallel line through** $(0, k)$: the point is the y-intercept, so $c = k$ straight away.
- **Choose the true statement** about two lines, or **explain** why a drawn line cannot have a given equation: compare gradients (sign and steepness) and y-intercepts. A line going down to the right cannot be $y = x + 2$, because that gradient is positive.

- **"Explain what parallel means"**: lines that stay the same distance apart and never meet.

4. Midpoint and length of a line segment (16 questions)

Extended only for the calculations (a Core question may ask you to mark a midpoint on a grid: count halfway in each direction).

1. **Midpoint:** add the x-values and halve; add the y-values and halve.
2. **Length:** find the change in x and the change in y, square both, add, square-root. Signs don't matter once squared.
3. Give the length **exactly** if asked ("as a surd in its simplest form"), otherwise to 3 significant figures.

Variations you will meet:

- **One end and the midpoint given.** Go the same step again: $A(2, 3)$ and midpoint $M(6, 8)$ is a step of $(+4, +5)$, so $B = (10, 13)$. Don't find the midpoint of A and M.
- **Surd form.** $\sqrt{68} = \sqrt{4 \times 17} = 2\sqrt{17}$. Take out the largest square factor.
- **Unknown point at a given distance**, such as a point $(0, k)$ on the y-axis 10 units from $(6, 1)$: $6^2 + (k - 1)^2 = 100$, so $(k - 1)^2 = 64$, $k - 1 = \pm 8$ and $k = 9$ or -7. Keep both.
- **Only one coordinate of the midpoint**, for example the y-coordinate: average just the y-values.

5. Reading, plotting and working out coordinates (16 questions)

1. **Read** across first, then up, using the scale on each axis; write (x, y) with a comma and brackets.
2. **Plot** with a small, clear cross or dot exactly on the grid point.
3. **Working out a point** from a shape or a movement: move in steps. "3 right and 2 down" from $(1, 4)$ is $(4, 2)$.

Variations you will meet:

- **Completing a shape.** For a square $ABCD$ with $A(0, 0)$ and $B(3, 1)$, the step from A to B is $(+3, +1)$. Turning it through 90° gives $(-1, +3)$, so $C = (2, 4)$ and $D = (-1, 3)$. Parallelograms: the step $A \to B$ equals the step $D \to C$.
- **A point dividing a line in a ratio.** Split the step into equal parts. For C on AB with $AC : CB = 1 : 3$, there are 4 parts; C is $\frac{1}{4}$ of the way from A to B. The same idea works with a known length ratio along a line: if D is on CE and $CE = 3 \times DE$, then C is 3 steps of $E \to D$ away from E. For $E(5, 6)$ and $D(4, 4)$ the step is $(-1, -2)$, so $C = (5 - 3,\ 6 - 6) = (2, 0)$.
- **Area of a shape** on a grid: count squares, or use $\frac{1}{2} \times$ base $\times$ height with lengths from the coordinates.
- Coordinates after a **translation** or an **enlargement** (covered with transformations): add the vector, or multiply the step from the centre.

6. Where a line crosses an axis or another line (14 questions)

1. **y-axis:** $x = 0$, so the point is $(0, c)$.
2. **x-axis:** put $y = 0$ and solve. For $y = \frac{1}{2}x + 3$: $0 = \frac{1}{2}x + 3$ gives $x = -6$, so $(-6, 0)$.

3. **Another line:** read the crossing point from the graph, or set the two expressions for y equal and solve, then find y.

Variations you will meet:

- **A horizontal line** such as $y = 19$: substitute, $19 = 2x - 5$, so $x = 12$.
- **An equation with brackets**, such as $y = 3(x + 2)$: multiply out first, $y = 3x + 6$, so it crosses the y-axis at $(0, 6)$.
- **Where a line meets a curve** (drawn on the same grid): read the x-values where they cross, to the accuracy of the grid.
- **Extended only: a line meeting a curve by algebra**, such as $y + 2x = 5$ and $y = x^2 - 3$: make y the subject, substitute, and solve the quadratic ($x^2 + 2x - 8 = 0$, so $x = 2$ or $x = -4$), then find each y ($(2, 1)$ and $(-4, 13)$).

7. Drawing and recognising straight-line graphs (9 questions)

1. Work out **three points** (a small table), or use c and the gradient: start at $(0, c)$ and go 1 across, m up.
2. Plot them and draw **one ruled line** through them, across the **full range** asked for.
3. For $x = k$ or $y = k$, draw the vertical or horizontal line straight away.

Variations you will meet:

- **"Use your graph to solve the simultaneous equations"**: the answer is the x and y of the crossing point.
- **Match equations to sketches:** $x = 3$ is vertical, $y = 3$ horizontal, $y = 3x$ goes through the origin and up to the right, $y = -3x$ through the origin and down.
- **Plot and join two given points**, then find the equation of that line (type 1).

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
- **A1** accuracy mark: for a correct answer; it needs the M mark before it.
- **B1** mark for a correct result on its own, with no method needed.

Example 1

Line L is drawn on a grid. It passes through the points $(0, -2)$ and $(4, 6)$.

(a) Find the gradient of line L. **[1]**

(b) Write down the equation of line L in the form $y = mx + c$. **[1]**

(c) Find the equation of the line parallel to L that passes through $(3, 1)$. **[2]**

(d) Find the coordinates of the point where line L crosses the x-axis. **[2]**

(a) From $(0, -2)$ to $(4, 6)$ is 4 across and 8 up. Gradient $= \frac{8}{4} = 2$. **B1**

(b) The line crosses the y-axis at -2, so $y = 2x - 2$. **B1**

(c) Parallel, so the gradient is still 2: $y = 2x + c$. **M1** for substituting $(3, 1)$: $1 = 2 \times 3 + c$, so $c = -5$.

$y = 2x - 5$ **A1**

(d) On the x-axis $y = 0$: $0 = 2x - 2$ **M1**, so $x = 1$. The point is $(1, 0)$. **A1**

Example 2

Extended. Line L has equation $3x + 2y = 12$.

(a) Find the gradient of L and the coordinates of the point where it crosses the y-axis. **[2]**

(b) Find the equation of the line parallel to L that passes through $(4, 1)$. Give your answer in the form $y = mx + c$. **[2]**

(c) Find the equation of the line perpendicular to L that passes through $(-3, 2)$. Give your answer in the form $y = mx + c$. **[3]**

(a) $2y = -3x + 12$, so $y = -\frac{3}{2}x + 6$.

Gradient $-\frac{3}{2}$ **B1**; crosses the y-axis at $(0, 6)$ **B1**.

(b) $y = -\frac{3}{2}x + c$ through $(4, 1)$: $1 = -\frac{3}{2} \times 4 + c = -6 + c$ **M1**, so $c = 7$.

$y = -\frac{3}{2}x + 7$ **A1**

(c) Perpendicular gradient $= -1 \div \left(-\frac{3}{2}\right) = \frac{2}{3}$. **M1**

$2 = \frac{2}{3} \times (-3) + c = -2 + c$ **M1**, so $c = 4$.

$y = \frac{2}{3}x + 4$ **A1**

Example 3

Extended. P is the point $(-5, 2)$ and Q is the point $(3, 8)$.

(a) Find the length of PQ. **[3]**

(b) Find the coordinates of the midpoint of PQ. **[2]**

(c) Find the equation of the perpendicular bisector of PQ. Give your answer in the form $y = mx + c$. **[4]**

(d) The perpendicular bisector crosses the x-axis at R. Find the x-coordinate of R. **[1]**

(a) Change in $x = 3 - (-5) = 8$; change in $y = 8 - 2 = 6$. **M1**

$PQ = \sqrt{8^2 + 6^2}$ **M1** $= \sqrt{100} = 10$ **A1**

(b) $\left(\frac{-5+3}{2}, \frac{2+8}{2}\right) = (-1, 5)$ **B2** (B1 for each coordinate)

(c) Gradient of $PQ = \frac{6}{8} = \frac{3}{4}$. **M1**

Perpendicular gradient $= -\frac{4}{3}$. **M1**

Through the midpoint $(-1, 5)$: $5 = -\frac{4}{3} \times (-1) + c = \frac{4}{3} + c$ **M1**, so $c = \frac{11}{3}$.

$y = -\frac{4}{3}x + \frac{11}{3}$ **A1**

(d) $0 = -\frac{4}{3}x + \frac{11}{3}$ gives $4x = 11$, so $x = \frac{11}{4} = 2.75$. **B1**

Example 4

Extended. A is the point $(1, -2)$ and B is the point $(7, 10)$.

(a) C is the point on AB such that $AC : CB = 1 : 2$. Find the coordinates of C. **[2]**

(b) The point $D(k, 5)$ lies on the line AB. Find the value of k. **[3]**

(c) The line through C perpendicular to AB meets the y-axis at E. Find the length CE, giving your answer as a surd in its simplest form. **[4]**

(a) The step from A to B is $(+6, +12)$. C is $\frac{1}{3}$ of the way along, a step of $(+2, +4)$. **M1**

$C = (1 + 2, -2 + 4) = (3, 2)$ **A1**

(b) Gradient of $AB = \frac{12}{6} = 2$. **M1** Through A: $-2 = 2 \times 1 + c$, so $c = -4$ and AB is $y = 2x - 4$. **M1**

$5 = 2k - 4$, so $k = 4.5$. **A1**

(c) Perpendicular gradient $= -\frac{1}{2}$. Through $C(3, 2)$: $2 = -\frac{1}{2} \times 3 + c$, so $c = 3.5$. **M1**

E is where $x = 0$, so $E = (0, 3.5)$. **A1**

$CE = \sqrt{(3-0)^2 + (2-3.5)^2} = \sqrt{9 + 2.25} = \sqrt{\frac{45}{4}}$ **M1**

$= \frac{\sqrt{45}}{2} = \frac{3\sqrt{5}}{2}$ **A1** (about 3.35)

Common mistakes

- **Gradient upside down.** It is change in y over change in x ("up over across"), not the other way round. A line through $(0, 3)$ and $(6, 0)$ has gradient $-\frac{1}{2}$, not -2.
- **Losing the minus sign.** A line that goes down from left to right has a negative gradient. Examiners regularly see $\frac{1}{2}$ where the answer was $-\frac{1}{2}$; look at the direction of the line before you write the answer.
- **Misreading the scale.** If 5 small squares make 1 unit, each small square is 0.2, not 0.1. Check both axes, and count squares in units, not boxes.
- **Mixing up the axes.** The y-intercept is where $x = 0$; the x-axis crossing is where $y = 0$. Read which one the question asks for.
- **Reading the gradient from the wrong form.** In $3y = 4x - 5$ the gradient is $\frac{4}{3}$, not 4: make y the subject first.
- **Half a negative reciprocal.** The perpendicular to gradient 2 is $-\frac{1}{2}$: flip **and** change the sign. $\frac{1}{2}$ (flip only) and -2 (sign only) score nothing for that step.
- **Using A or B instead of the midpoint** in a perpendicular bisector. The bisector goes through the midpoint, never through the ends.
- **Using the wrong point.** "Perpendicular to l through the origin" means $c = 0$, not the c of line l or a point from an earlier part.
- **Midpoint of the wrong pair.** If M is the midpoint and you need the end B, go from M the same step again. Averaging A and M gives a point a quarter of the way along.
- **An equation with no numbers**, such as "$y = mx + c$" or "$y = 3x$" when the line clearly does not pass through the origin. The answer must be a full equation with the gradient and intercept put in.
- **Lines that are not at right angles.** When drawing a perpendicular on a grid, check the angle with a protractor or by gradients; many drawn lines are far from 90°, or parallel instead.
- **Rounding a length early**, then using it in the next part. Keep the surd or the full calculator value.

How to get the marks

- **"Give your answer in the form $y = mx + c$"**: the final answer must be exactly that, fully simplified, such as $y = -2x + 31$. A correct equation in another form usually loses a mark.
- **Method marks:** a correct rise over run (or a triangle drawn on the graph with the numbers marked) earns a mark even if later work goes wrong; so does "$y = mx + c$" with your gradient and the correct c. Show the gradient working.
- **Follow through:** a wrong gradient from an earlier part, used correctly with the right point, still earns the substitution mark. Keep going.
- **Perpendicular bisector (5 marks):** typically one for the midpoint, one for the gradient of the segment, one for the perpendicular gradient and one for substituting the midpoint. Write each step on its own line.

- **"Show that"** the equation is ...: you cannot just quote it. Find the gradient, the perpendicular gradient and c with working, then rearrange to the printed form.
- **"Write down"** means no working is needed (for example, the gradient of $y = 5x + 7$ is 5). **"Find"** or **"calculate"** needs working.
- **"Coordinates"** means both numbers in brackets, such as $(0, -3)$, not just -3.
- **Drawing lines:** use a ruler, go across the whole range given, and pass through the right grid points; a short or freehand line loses a mark.
- **Lengths:** "surd in its simplest form" means the largest square taken out ($3\sqrt{17}$, not $\sqrt{153}$). Otherwise give 3 significant figures.

Quick check

1. Write down the gradient of the line $y = 7 - 4x$ and the coordinates of the point where it crosses the y-axis.
2. *Extended.* Find the equation of the straight line through $(-2, -1)$ and $(6, 3)$. Give your answer in the form $y = mx + c$.
3. *Extended.* Find the gradient of a line perpendicular to $5x + 2y = 9$.
4. *Extended.* $M(3, -1)$ is the midpoint of AB, and A is the point $(-2, 4)$. Find the coordinates of B and the length of AB.
5. Find the coordinates of the point where the lines $y = 3x - 7$ and $y = -x + 5$ meet.

Answers

1. $y = -4x + 7$: gradient -4; it crosses the y-axis at $(0, 7)$.
2. $m = \dfrac{3-(-1)}{6-(-2)} = \dfrac{4}{8} = \dfrac{1}{2}$. Through $(6, 3)$: $3 = \dfrac{1}{2} \times 6 + c$, so $c = 0$. The line is $y = \dfrac{1}{2}x$ (it passes through the origin).
3. $2y = -5x + 9$, so $y = -\dfrac{5}{2}x + \dfrac{9}{2}$ and the gradient is $-\dfrac{5}{2}$. The perpendicular gradient is $\dfrac{2}{5}$.
4. The step from A to M is $(+5, -5)$, so $B = (3+5, -1-5) = (8, -6)$. $AB = \sqrt{10^2 + (-10)^2} = \sqrt{200} = 10\sqrt{2} \approx 14.1$.
5. $3x - 7 = -x + 5$, so $4x = 12$ and $x = 3$; $y = 3 \times 3 - 7 = 2$. The point is $(3, 2)$.

Past questions to try

- **0580/31/M/J/21 Q4**: reading a point, the gradient and equation from a grid, and drawing a perpendicular.
- **0580/22/F/M/22 Q16**: a line through two points, then a perpendicular through the origin.
- **0580/43/M/J/23 Q11**: length, gradient and the perpendicular bisector of a segment.
- **0580/41/M/J/23 Q6**: completing a square from two vertices, then midpoint, length and a parallel line.