IGCSE MATHEMATICS 0580 · CHAPTER 6 NOTES · ~25 MIN READ

Coordinate geometry

Gradient, y = mx + c, midpoints, lengths and parallel and perpendicular lines, all built from one picture: the gradient triangle. Learn to write the equation of any straight line in four steps.

Gradient | y = mx + c | Midpoint & length | Parallel & perpendicular lines

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No tag = **Core** (everyone) EXTENDED Extended only highlight = comes up again and again

Test yourself at the end

IN 30 SECONDS

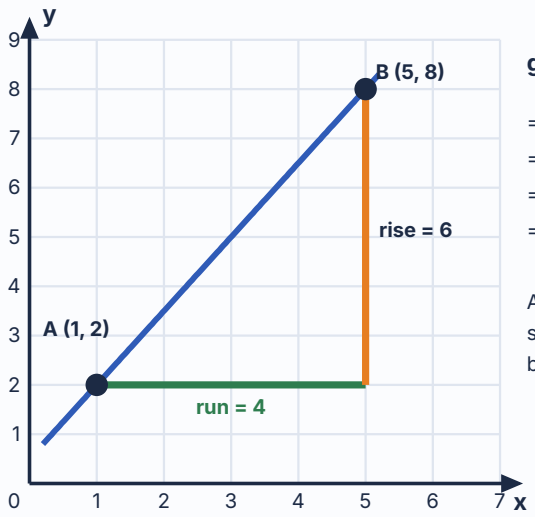
- **Gradient = rise ÷ run** = $(y_2 - y_1) \div (x_2 - x_1)$. Every straight line has the equation **y = mx + c**, where **m** is the gradient and **c** is where it crosses the **y-axis**.
- The **midpoint** is the **average** of the x-values and the y-values. The **length** of a line segment comes from **Pythagoras** on the gradient triangle.
- **Parallel** lines have the **same m**. **Perpendicular** lines (Extended) have gradients that multiply to **−1**.

BY THE END YOU CAN

- Find the gradient of a line from a graph or from two points.
- Write down the gradient and y-intercept from y = mx + c, and rearrange equations into this form.
- Find the midpoint and the length of a line segment.
- Find the equation of a line from its gradient and a point, or from two points.
- Find the equation of a line parallel to a given line.
- Use $m_1 \times m_2 = -1$ for perpendicular lines and find a perpendicular bisector. EXT

1 Gradient

Rise over run



gradient m = rise ÷ run

$= (y_2 - y_1) \div (x_2 - x_1)$
$= (8 - 2) \div (5 - 1)$
$= 6 \div 4$
$= 1.5$

Always subtract in the same order on top and bottom.

Draw a right-angled triangle under the line: the vertical side is the rise and the horizontal side is the run.

Gradient — how **steep** a line is. It is the **change in y** (rise) divided by the **change in x** (run) between any two points on the line.

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

subtract the coordinates in the **same order** on top and bottom

- **Any two points** on the line give the **same** gradient. A straight line is the same steepness everywhere.
- **Read from a graph:** use the **scale on the axes**, not the number of squares. Choose two points that sit **exactly on grid crossings** and as far apart as you can.

WORKED EXAMPLE

Find the gradient of the line through A(1, 2) and B(5, 8).

1. rise = 8 − 2 = 6
2. run = 5 − 1 = 4
3. **m = 6 ÷ 4 = 1.5**

WORKED EXAMPLE

Find the gradient of the line through (−2, 5) and (4, −1).

1. rise = −1 − 5 = −6
2. run = 4 − (−2) = 6
3. m = −6 ÷ 6 = **−1**
4. **the line falls as you go right**

COMMON MISTAKE

Subtracting in a **different order** on top and bottom, such as (8 − 2) ÷ (1 − 5). That gives **−1.5** and the wrong sign. Keep the **same point first** on both lines.

Four kinds of gradient



positive	negative	zero	undefined
rises: m > 0	**falls: m < 0**	**flat: m = 0**	**vertical: no m**
y = 2x + 1	y = −x + 3	y = 4	x = 3

Read a line from left to right: if it climbs the gradient is positive, if it drops it is negative.

- **Positive:** the line **rises** from left to right. **Negative:** it **falls**.
- **Zero:** a **horizontal** line y = c is flat, so rise = 0.
- **Undefined:** a **vertical** line x = c has run = 0, and you cannot divide by 0. It has **no gradient**.
- **Steeper = bigger number** (ignoring the sign): m = 3 is steeper than m = 1 and m = −4 is steeper than m = −2.

WORKED EXAMPLE

Find the gradient of the line through (3, 4) and (7, 4).

1. rise = 4 − 4 = 0
2. run = 7 − 3 = 4
3. **m = 0 ÷ 4 = 0, a horizontal line y = 4**

WORKED EXAMPLE

The line through (1, 3) and (5, k) has gradient 2. Find k.

1. gradient = $\frac{k - 3}{5 - 1} = 2$
2. $k - 3 = 8$
3. **k = 11**
4. **check: (11 − 3) ÷ 4 = 2 ✓**

Are three points in a straight line?

- **Collinear** points lie on **one straight line**. Find the gradient of the **first pair** and of the **second pair**. If they match, the points are collinear.

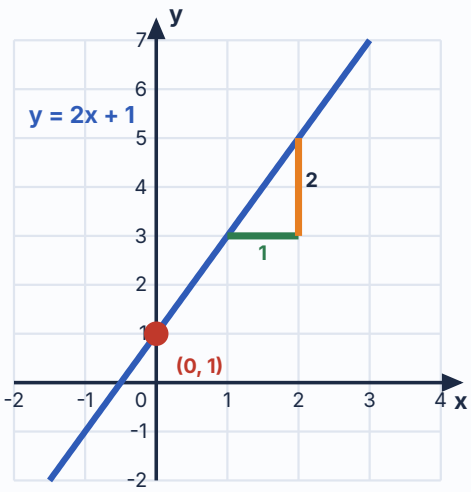
WORKED EXAMPLE

Show that A(1, 2), B(3, 6) and C(5, 10) lie on a straight line.

1. gradient AB = (6 − 2) ÷ (3 − 1) = 4 ÷ 2 = **2**
2. gradient BC = (10 − 6) ÷ (5 − 3) = 4 ÷ 2 = **2**
3. **the gradients are equal and B is shared, so the points are collinear**

2 The equation of a straight line

y = mx + c



y = mx + c

m = gradient
(steepness: rise ÷ run)
c = y-intercept
(where the line crosses the y-axis)
here m = 2 and c = 1

Every point on the line has coordinates that fit the equation. m tells you the slope and c tells you where the line starts on the y-axis.

y-intercept — the point where the line crosses the **y-axis**. It always has **x = 0**, so the point is **(0, c)**.

$$y = mx + c$$

m = gradient, **c** = y-intercept

- **To read m and c, the equation must start with y = ...** Rearrange first if it does not (see Algebraic manipulation).
- **Sign matters:** in y = 3x − 5 the intercept is **c = −5**, so the line crosses at **(0, −5)**.

WORKED EXAMPLE

Write down the gradient and y-intercept of y = 3x − 5.

1. compare with y = mx + c
2. gradient **m = 3**
3. **y-intercept c = −5, so the point is (0, −5)**

WORKED EXAMPLE

Find the gradient and y-intercept of 4x + 2y = 10.

1. rearrange to y = ... : 2y = −4x + 10
2. divide by 2: y = −2x + 5
3. **gradient −2, y-intercept 5**

WORKED EXAMPLE

Does the point (3, 10) lie on the line y = 2x + 4?

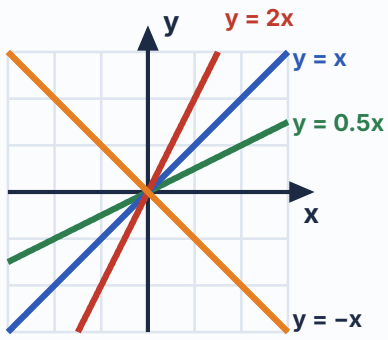
1. substitute x = 3: y = 2(3) + 4 = 10
2. **this equals the y-value, so yes, it lies on the line**

COMMON MISTAKE

Reading the gradient from 3y = 6x + 12 as **6**. Divide **every term** by 3 first: y = 2x + 4, so m = **2**.

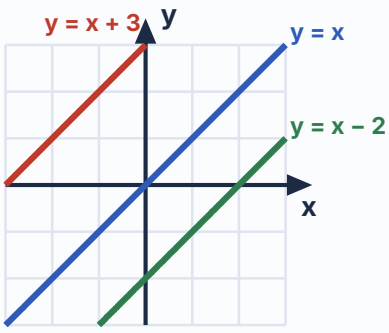
How m and c change the line

Change m: the steepness



c = 0: all pass through the origin

Change c: shifts up or down



same m = 1: the lines are parallel

Changing m changes the steepness. Changing c slides the whole line up or down without turning it.

- **Bigger m** = steeper line. **c = 0** means the line passes through the **origin** (0, 0).
- **Same m, different c** = **parallel** lines. They are the same steepness but start at different heights.

WORKED EXAMPLE

Write the equation of the line with gradient −2 that crosses the y-axis at (0, 5).

1. use y = mx + c with m = −2 and c = 5
2. **y = −2x + 5**

MEMORY TRICK

m = "how much y changes for each 1 step right". y = 3x + 2 means: start at 2 on the y-axis and go **up 3** for every **1** step to the right.

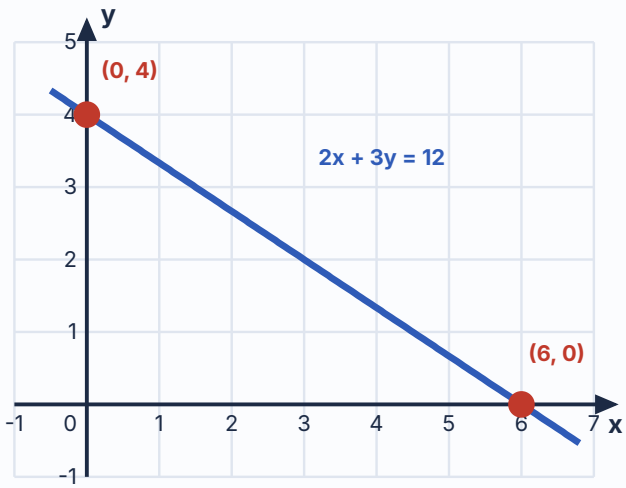
Horizontal and vertical lines

- **Horizontal:** y = 4 is the line where **every point has y = 4**. Its gradient is 0.
- **Vertical:** x = 3 is the line where **every point has x = 3**. It has no gradient and it cannot be written as y = mx + c.

COMMON MISTAKE

Mixing them up. **x = 3** is **vertical** (it crosses the x-axis at 3). **y = 3** is **horizontal** (it crosses the y-axis at 3). Remember: x = 3 **cuts the x-axis at 3** and stands upright, like a post.

Lines written as ax + by = c



ax + by = c

x = 0: 3y = 12, y = 4
y = 0: 2x = 12, x = 6
join (0, 4) and (6, 0)
or rearrange:
3y = −2x + 12
y = −(2/3)x + 4

To find where the line crosses each axis, set x = 0 for the y-intercept and y = 0 for the x-intercept.

- **Cover-up method:** put **x = 0** to find where the line crosses the **y-axis**. Put **y = 0** to find where it crosses the **x-axis**. Join the two points to draw the line.
- **Gradient of ax + by = c:** rearrange to y = ... or use the shortcut **m = −a ÷ b**.

WORKED EXAMPLE

Find where the line 2x + 3y = 12 crosses the axes, and write down its gradient.

1. x = 0: 3y = 12, so y = 4: point **(0, 4)**
2. y = 0: 2x = 12, so x = 6: point **(6, 0)**
3. **gradient = −2 ÷ 3 = $-\frac{2}{3}$**

WORKED EXAMPLE

Find the intercepts of 5x − 2y = 20.

1. x = 0: −2y = 20, so y = −10: point **(0, −10)**
2. y = 0: 5x = 20, so x = 4: point **(4, 0)**
3. **check (4, 0): 5(4) = 20 ✓**

The line in real life

- **Gradient = rate of change.** In a cost graph C = 0.5d + 3 the **gradient 0.5** is the **cost per kilometre** and the **y-intercept 3** is the **fixed charge**.
- **Units of the gradient:** (units of y) ÷ (units of x), such as **$ per km** or **metres per second**. Always say what the gradient **means**.

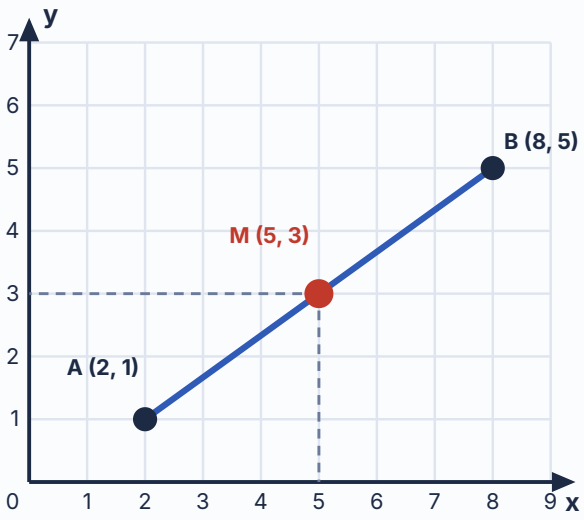
WORKED EXAMPLE

A taxi charges a fixed fee plus a cost per kilometre. The cost is C = 0.5d + 3 dollars for d kilometres. What does the 3 mean? What is the cost of 12 km?

1. the **3** is the **fixed fee** ($3 before you travel)
2. **C = 0.5 × 12 + 3 = 6 + 3 = $9**

3 Midpoint and length of a line

The midpoint



midpoint =
the average of the
x-values and the
average of the y-values

x: (2 + 8) ÷ 2 = 5
y: (1 + 5) ÷ 2 = 3
M = (5, 3)

The midpoint is halfway along the line, so its coordinates are the averages of the end coordinates.

Midpoint — the point exactly **halfway** between two points on a line segment.

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

add and halve the x-values, then **add and halve** the y-values

WORKED EXAMPLE

Find the midpoint of A(2, 1) and B(8, 5).

1. x: (2 + 8) ÷ 2 = 5
2. y: (1 + 5) ÷ 2 = 3
3. **M = (5, 3)**

WORKED EXAMPLE

Find the midpoint of (−3, 4) and (7, −2).

1. x: (−3 + 7) ÷ 2 = 4 ÷ 2 = 2
2. y: (4 + (−2)) ÷ 2 = 2 ÷ 2 = 1
3. **M = (2, 1)**

WORKED EXAMPLE

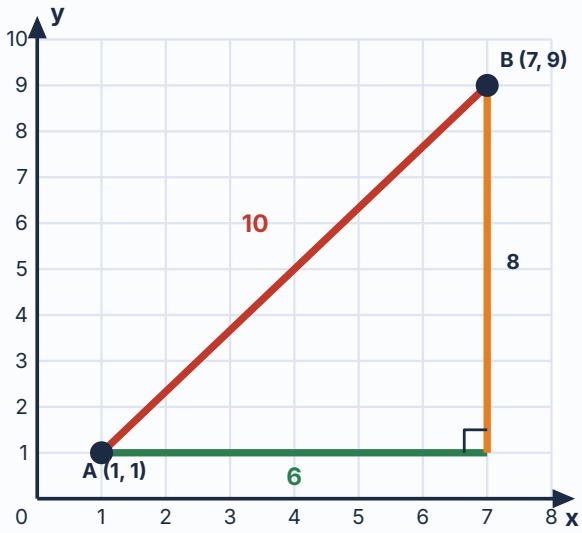
M(4, 5) is the midpoint of AB and A is (1, 2). Find B.

1. x: from 1 to 4 is +3, so keep going: 4 + 3 = 7
2. y: from 2 to 5 is +3, so 5 + 3 = 8
3. **B = (7, 8)**
4. **check: (1 + 7) ÷ 2 = 4 and (2 + 8) ÷ 2 = 5 ✓**

MEMORY TRICK

Finding an end point: the midpoint is the **same distance** from both ends, so **jump again** by the same amount. Or use B = 2M − A for each coordinate.

The length of a line segment



length of AB

use Pythagoras:

$AB^2 = run^2 + rise^2$

$AB^2 = 6^2 + 8^2$

$AB^2 = 36 + 64 = 100$

$AB = \sqrt{100} = 10$

Draw a right-angled triangle on the line. The line is the hypotenuse, so use Pythagoras.

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

this is just **Pythagoras** on the gradient triangle

- **Steps:** (1) find the **run** and the **rise** by subtracting; (2) **square** both and **add**; (3) **square root** the total.
- **Negative differences are fine:** a negative squared is **positive**. Square the **whole** difference.

WORKED EXAMPLE

Find the length of AB where A is (1, 1) and B is (7, 9).

1. run = 7 − 1 = 6 and rise = 9 − 1 = 8
2. $AB^2 = 6^2 + 8^2 = 36 + 64 = 100$
3. **AB = √100 = 10 units**

WORKED EXAMPLE

Find the length of the line from (−2, 3) to (4, −1). Give your answer to 3 significant figures.

1. run = 4 − (−2) = 6 and rise = −1 − 3 = −4
2. $\text{length}^2 = 6^2 + (-4)^2 = 36 + 16 = 52$
3. **length = √52 = 7.21 units**

WORKED EXAMPLE

The vertices of a triangle are A(0, 0), B(3, 4) and C(6, 0). Show that the triangle is isosceles.

1. $AB = \sqrt{(3^2 + 4^2)} = \sqrt{25} = \mathbf{5}$
2. $BC = \sqrt{((6 - 3)^2 + (0 - 4)^2)} = \sqrt{(9 + 16)} = \mathbf{5}$
3. **AB = BC, so the triangle is isosceles**

WORKED EXAMPLE

EXT **The distance from (1, 2) to (k, 5) is 5. Find the possible values of k.**

1. $(k - 1)^2 + (5 - 2)^2 = 25$
2. $(k - 1)^2 + 9 = 25$, so $(k - 1)^2 = 16$
3. $k - 1 = 4$ or $k - 1 = -4$
4. **k = 5 or k = −3**

COMMON MISTAKE

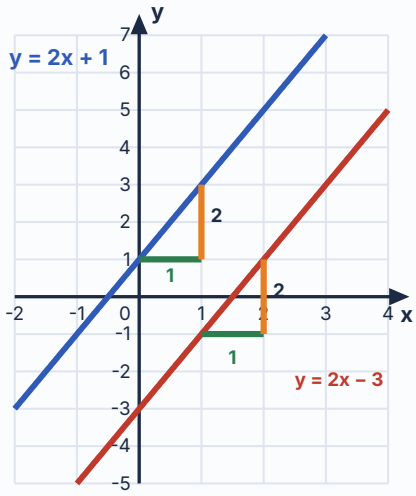
Forgetting the **final square root**. $6^2 + 8^2 = 100$ is the length **squared**. The length is **√100 = 10**.

EXAM TIP

Draw a **quick sketch** of the two points and the triangle. It shows you the sizes of the run and rise and tells you whether your answer is sensible: the length must be **longer** than the rise and the run.

4 Parallel lines

Same gradient, different c



Parallel lines

have the SAME gradient.
y = 2x + 1 has m = 2
y = 2x − 3 has m = 2
Different c, so they never meet.

Parallel lines climb at exactly the same rate, so they never meet.

Parallel lines — lines with the **same gradient**. They are always the same distance apart and never meet.

- **To check:** rearrange both equations to y = mx + c and compare the **m** values.
- **To find a parallel line:** keep the **same m** and find a new **c** by substituting a **point** on the new line.

WORKED EXAMPLE

Which of these lines are parallel? y = 2x + 1, 4x − 2y = 5, y = −2x + 3.

1. line 1: m = 2
2. line 2: −2y = −4x + 5, so y = 2x − 2.5, m = 2
3. line 3: m = −2
4. **lines 1 and 2 are parallel**

WORKED EXAMPLE

Find the equation of the line parallel to y = 3x − 2 that passes through (2, 7).

1. parallel, so m = 3: y = 3x + c
2. substitute (2, 7): 7 = 3(2) + c = 6 + c
3. c = 1
4. **y = 3x + 1**

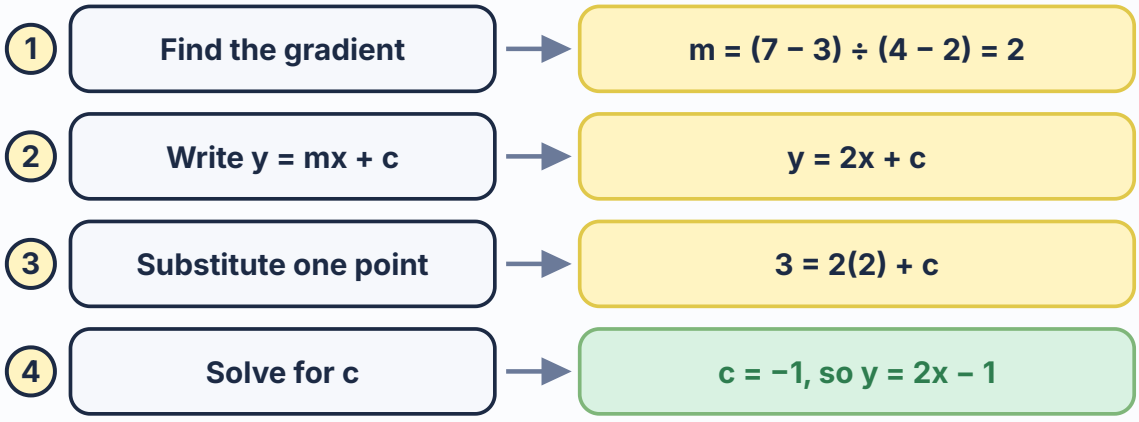
COMMON MISTAKE

Saying y = 3x − 2 and y = −3x − 2 are parallel because they have the "same number". They have **different gradients** (3 and −3). They cross the y-axis at the same point, so they are **not** parallel.

5 Equation of a line from information

Four steps to any line

Find the equation of the line through (2, 3) and (4, 7)



check with the other point (4, 7): 2(4) − 1 = 7 ✓

Find m, write y = mx + c, substitute a point to find c, then check with the other point.

- **Step 1:** find the **gradient m**. **Step 2:** write **y = mx + c** with that m. **Step 3:** substitute **one known point** to find **c**. **Step 4:** write the full equation and **check** with the other point.
- **If you are given m and a point,** start at step 2.

WORKED EXAMPLE

Find the equation of the line through (2, 3) and (4, 7).

1. m = (7 − 3) ÷ (4 − 2) = **2**
2. y = 2x + c
3. substitute (2, 3): 3 = 2(2) + c, so c = −1
4. **y = 2x − 1**
5. **check (4, 7): 2(4) − 1 = 7 ✓**

WORKED EXAMPLE

Find the equation of the line through (−1, 5) and (3, −3).

1. m = (−3 − 5) ÷ (3 − (−1)) = −8 ÷ 4 = **−2**
2. y = −2x + c
3. substitute (−1, 5): 5 = −2(−1) + c = 2 + c, so c = 3
4. **y = −2x + 3**
5. **check (3, −3): −2(3) + 3 = −3 ✓**

WORKED EXAMPLE

Find the equation of the line with gradient $\frac{1}{2}$ that passes through (6, 1).

1. $y = \frac{1}{2}x + c$
2. substitute (6, 1): 1 = 3 + c
3. c = −2
4. **$y = \frac{1}{2}x - 2$**

WORKED EXAMPLE

A line crosses the y-axis at (0, −4) and the x-axis at (2, 0). Find its equation.

1. m = (0 − (−4)) ÷ (2 − 0) = 4 ÷ 2 = **2**
2. the y-intercept is given: c = −4
3. **y = 2x − 4**

EXAM TIP

The y-intercept is a **shortcut**: if the line crosses the y-axis at (0, c) you already know **c**, and you only need to find **m**.

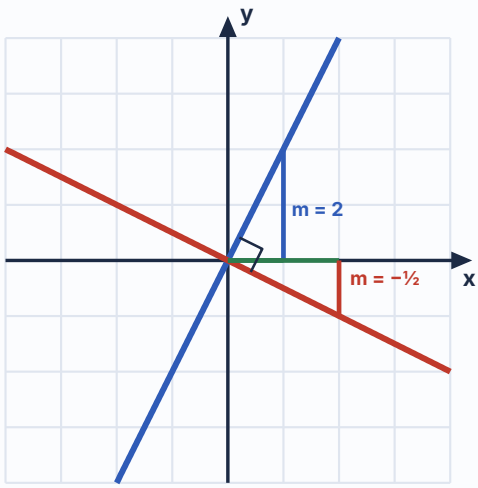
COMMON MISTAKE

Putting the **x-coordinate** and the **y-coordinate** the wrong way round when you substitute a point. In the point (2, 3) the **x is 2** and the **y is 3**.

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6 Perpendicular lines EXT

Negative reciprocals



Perpendicular lines

meet at 90°.
$m_1 \times m_2 = -1$
$2 \times (-½) = -1$
Flip the fraction and change the sign:
2 → −½
¾ → −4/3

If one line has gradient m, a line at 90° to it has gradient −1/m: flip the fraction and change the sign.

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Perpendicular lines — lines that meet at **90°**. Their gradients **multiply to −1**.

$$m_1 \times m_2 = -1$$

so $m_2 = -1 \div m_1$, the **negative reciprocal**

- EXT **Flip** the fraction and **change the sign**: 2 → $-\frac{1}{2}$, $-\frac{3}{4}$ → $\frac{4}{3}$, 5 → $-\frac{1}{5}$.
- EXT A **horizontal** line (m = 0) is perpendicular to a **vertical** line. This is the only case where the rule does not work.

WORKED EXAMPLE

EXT **Find the equation of the line perpendicular to y = 2x + 1 that passes through (4, 3).**

1. gradient of the given line = 2, so m = $-\frac{1}{2}$
2. $y = -\frac{1}{2}x + c$
3. substitute (4, 3): 3 = −2 + c, so c = 5
4. **$y = -\frac{1}{2}x + 5$**

WORKED EXAMPLE

EXT **Show that 3y = x + 6 and y = −3x + 2 are perpendicular.**

1. line 1: $y = \frac{1}{3}x + 2$, so $m_1 = \frac{1}{3}$
2. line 2: $m_2 = -3$
3. **$m_1 \times m_2 = \frac{1}{3} \times (-3) = -1$, so the lines are perpendicular**

WORKED EXAMPLE

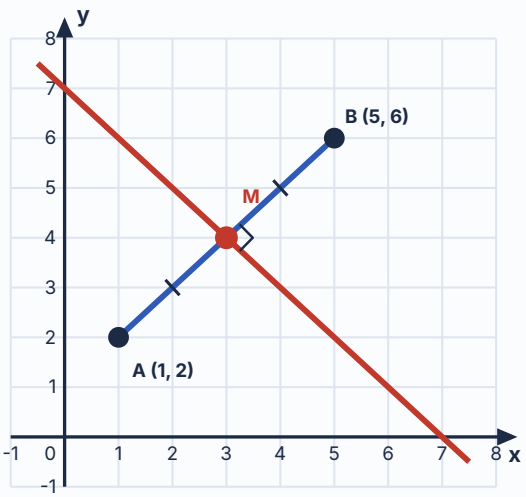
EXT **Find the line perpendicular to 2y + 3x = 6 that passes through (3, 1).**

1. $2y = -3x + 6$, so $y = -\frac{3}{2}x + 3$, giving $m_1 = -\frac{3}{2}$
2. perpendicular: $m_2 = \frac{2}{3}$
3. $y = \frac{2}{3}x + c$, and $1 = \frac{2}{3}(3) + c = 2 + c$, so $c = -1$
4. **$y = \frac{2}{3}x - 1$**

COMMON MISTAKE

EXT Changing the sign but **not flipping** (2 becomes −2), or flipping but **not changing the sign** (2 becomes $\frac{1}{2}$). You need **both**.

Perpendicular bisector



Perpendicular bisector of AB

1. midpoint M = (3, 4)
2. gradient of AB = 1
3. perpendicular gradient = −1
4. y − 4 = −1(x − 3)
   y = −x + 7

The perpendicular bisector cuts a line segment in half at a right angle. It goes through the midpoint with the negative reciprocal gradient.

Perpendicular bisector — the line that passes through the **midpoint** of AB and is **perpendicular** to AB.

- EXT **Steps:** (1) find the **midpoint** of AB; (2) find the **gradient of AB**; (3) take the **negative reciprocal**; (4) use the midpoint and the new gradient to find **c**.

WORKED EXAMPLE

EXT **A is (1, 2) and B is (5, 6). Find the equation of the perpendicular bisector of AB.**

1. midpoint M = (3, 4)
2. gradient of AB = (6 − 2) ÷ (5 − 1) = 1
3. perpendicular gradient = −1
4. y = −x + c, and 4 = −3 + c, so c = 7
5. **y = −x + 7**

WORKED EXAMPLE

EXT **A is (−2, 1) and B is (4, 5). Find the perpendicular bisector of AB.**

1. midpoint M = (1, 3)
2. gradient of AB = 4 ÷ 6 = $\frac{2}{3}$
3. perpendicular gradient = $-\frac{3}{2}$
4. $3 = -\frac{3}{2}(1) + c$, so c = 4.5
5. **y = −1.5x + 4.5**
6. **check M: −1.5 + 4.5 = 3 ✓**

EXAM TIP

Every point on the perpendicular bisector is the **same distance from A and from B**. That is why it is used in **loci** and **constructions**.

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7 Test yourself

Test yourself — cover the answers first

QUICK CHECK

1. Which is steeper: a line with m = −5 or a line with m = 3?
2. EXT What is the gradient of a line perpendicular to y = 4x − 1?
3. Find the gradient of the line through (1, 3) and (4, 12).
4. Find the gradient of the line through (2, 7) and (6, 3).
5. Write down the gradient of y = 5 − 2x.
6. Write down the y-intercept of y = 4x − 7.
7. Find the gradient and y-intercept of 3x + y = 8.
8. What is the gradient of the horizontal line y = 6?
9. Does the vertical line x = 2 have a gradient?
10. Find the points where 3x + 4y = 24 crosses the axes.
11. Does the point (2, −3) lie on y = 4x − 11?
12. Find the midpoint of (4, 1) and (10, 7).
13. Find the midpoint of (−6, 3) and (2, −5).
14. Find the distance from (0, 0) to (5, 12).
15. Find the distance from (1, 2) to (4, 6).
16. Find the distance from (−1, −2) to (3, 1).
17. Find the line parallel to y = 2x + 5 that passes through (0, −1).
18. Find the line parallel to y = −x + 4 that passes through (3, 2).
19. Find the equation of the line with gradient 3 through (1, 5).
20. Find the equation of the line through (0, 3) and (4, 11).
21. A is (2, 3) and the midpoint of AB is (5, 7). Find B.
22. Show that (0, 1), (2, 5) and (5, 11) are collinear.
23. EXT What is the gradient of a line perpendicular to a line with gradient $-\frac{2}{3}$?
24. EXT Are y = 2x + 3 and 2y + x = 4 perpendicular?
25. EXT Find the line perpendicular to y = −3x + 2 that passes through (6, 5).
26. EXT Find the perpendicular bisector of A(0, 0) and B(6, 2).
27. EXT Find the length of the line from (−3, 2) to (1, 6) to 2 decimal places.

EXAM-STYLE

28. Find the equation of the line through (1, 4) and (3, 10). [3]
29. A is (−2, 3) and B is (6, 9). Find (a) the midpoint of AB and (b) the length of AB. [4]
30. The line L passes through (0, −2) and is parallel to 3x − y = 5. Find the equation of L. [3]
31. A taxi charges a fixed fee plus a rate per kilometre. A 4 km journey costs $11 and a 10 km journey costs $20. Find the formula C = md + c and say what m means. [4]
32. A is (1, 1), B is (4, 5) and C is (8, 2). Show that triangle ABC is right-angled. [4]
33. Show that P(−1, 0), Q(2, 6) and R(4, 10) lie on a straight line. [3]
34. EXT The line L_1 has equation 3x + 2y = 12. The line L_2 is perpendicular to L_1 and passes through (3, 5). Find the equation of L_2. [4]

35. EXT A is (−1, −2) and B is (5, 2). Find the equation of the perpendicular bisector of AB. [5]

36. EXT AB is a diameter of a circle with A(1, 2) and B(7, 10). Find the centre and the radius. [4]

37. EXT The line through (3, k) and (7, 10) has gradient $\frac{3}{2}$. Find k. [3]

38. EXT Find the coordinates of the point where y = 2x + 3 meets y = −x + 9. [3]

Riyaz Sir

Show answers

1. m = −5, since 5 is bigger than 3. The minus sign only tells you it falls.
2. $-\frac{1}{4}$
3. 3
4. −1
5. −2
6. (0, −7)
7. gradient −3, y-intercept 8
8. 0
9. No, it is undefined
10. (0, 6) and (8, 0)
11. Yes: 4(2) − 11 = −3
12. (7, 4)
13. (−2, −1)
14. 13
15. 5
16. 5
17. y = 2x − 1
18. y = −x + 5
19. y = 3x + 2
20. y = 2x + 3
21. (8, 11)
22. both gradients are 2
23. $\frac{3}{2}$
24. Yes: the gradients are 2 and $-\frac{1}{2}$, and $2 \times (-\frac{1}{2}) = -1$
25. $y = \frac{1}{3}x + 3$
26. M = (3, 1), gradient −3, so y = −3x + 10
27. √32 = 5.66
28. m = (10 − 4) ÷ (3 − 1) = 3
    y = 3x + c and 4 = 3 + c, so c = 1
    y = 3x + 1
29. (a) ((−2 + 6) ÷ 2, (3 + 9) ÷ 2) = (2, 6)
    (b) run = 8 and rise = 6, so AB = √(64 + 36) = √100 = 10
30. rearrange: y = 3x − 5, so m = 3
    L has the same gradient and c = −2
    y = 3x − 2

31. $m = (20 - 11) \div (10 - 4) = 1.5$
    $11 = 1.5(4) + c$, so $c = 5$
    $C = 1.5d + 5$
    $m = \$1.50$ per kilometre

32. $AB^2 = 3^2 + 4^2 = 25$
    $BC^2 = 4^2 + 3^2 = 25$
    $AC^2 = 7^2 + 1^2 = 50$
    $AB^2 + BC^2 = 50 = AC^2$, so the angle at B is 90°

33. gradient PQ $= 6 \div 3 = 2$
    gradient QR $= 4 \div 2 = 2$
    equal gradients and Q is shared, so P, Q and R are collinear

34. $2y = -3x + 12$, so $m_1 = -1.5$
    $m_2 = \frac{2}{3}$
    $5 = \frac{2}{3}(3) + c = 2 + c$, so $c = 3$
    $y = \frac{2}{3}x + 3$

35. midpoint $= (2, 0)$
    gradient AB $= 4 \div 6 = \frac{2}{3}$
    perpendicular gradient $= -1.5$
    $0 = -1.5(2) + c$, so $c = 3$
    $y = -1.5x + 3$

36. centre = midpoint $= (4, 6)$
    $AB = \sqrt{(6^2 + 8^2)} = \sqrt{100} = 10$
    radius $= 10 \div 2 = 5$

37. $(10 - k) \div (7 - 3) = 1.5$
    $10 - k = 6$
    $k = 4$

38. $2x + 3 = -x + 9$, so $3x = 6$ and $x = 2$
    $y = 2(2) + 3 = 7$
    $(2, 7)$

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Ask Riyaz Sir

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