●●●○○ Level 3 · Mathematics M3.9

Coordinates and straight lines

Plot points on a grid and draw the straight lines that rules make.

Name any place on a grid with two numbers, in all four quarters. Move and flip shapes. Then turn a rule such as y = 2x + 1 into a straight line, measure how steep it is, and read graphs from real life.

YOU ARE READY FOR THIS BOOK IF

You can find the value of 2x + 3 when x = 4.

One step up	M4.8 Linear and simultaneous equations
This book	**M3.9 Coordinates and straight lines**
One step down	M2.8 Patterns and rules

Contents

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M3.9.2 All four quarters of the grid

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M3.9.6 Steepness: the gradient

M3.9.7 The equation y = mx + c

M3.9.8 Graphs from real life

Key words, A to Z

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M3.9.1 CHAPTER 1

Coordinates

How can I tell a friend exactly where a spot is, using only numbers?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Go 5 across, then 3 up. The first number is how far up.
- ☐ **B** Go 3 across, then 5 up. The first number is how far across.
- ☐ **C** Either way. The two numbers reach the same place in any order.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Letters for numbers and simple equations, M3.8.2. Later chapters put numbers into rules like 2x + 1.
- Level 2, Tables and charts, M2.7.4. A grid names a place by two things, like a row and a column.

BY THE END YOU CAN

- Plot a point like (3, 5), going across first and then up
- Read the coordinates of a point on a grid

On a town map, a letter and a number can name each square. A grid in mathematics does the same with two numbers. The two numbers name one exact place.

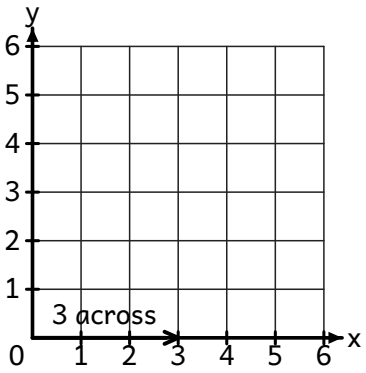
A grid has two number lines. The one that goes across is the **x axis**. The one that goes up is the **y axis**. They cross at the **origin**, where both numbers are 0.

The two numbers for a place are its **coordinates**. We write them in brackets, with a comma: (3, 5). The first number tells how far across. The second tells how far up.

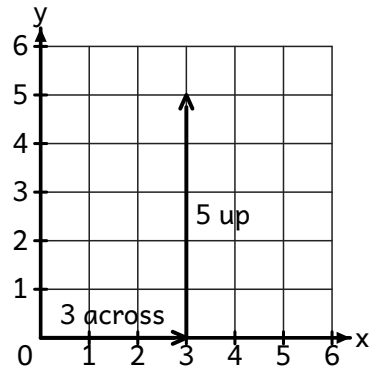
To remember the order, think of a corridor and a staircase. You walk along the corridor first. Then you climb the stairs. Across first, then up.

DRAW IT FIRST

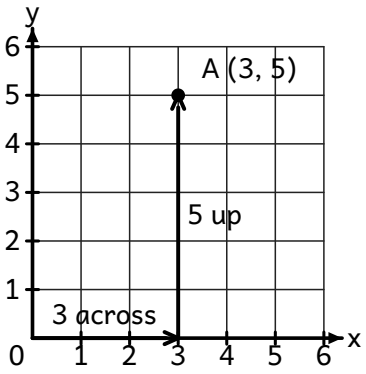
Plot the point (3, 5)



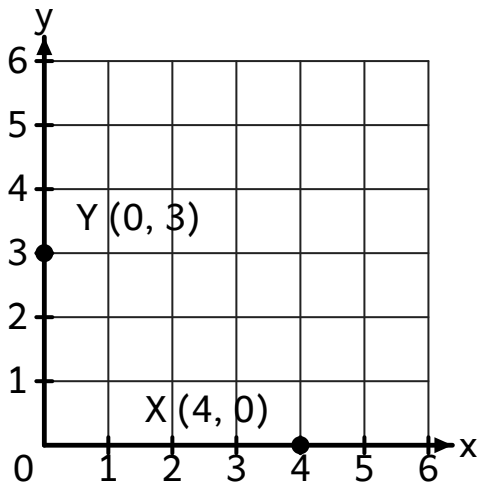
1 Start at the origin, where the two axes cross. Its coordinates are (0, 0). Go 3 across along the x axis.



2 Stay where you are across. Now go 5 up.



3 Mark a dot. Write the letter A beside it. The point is (3, 5).



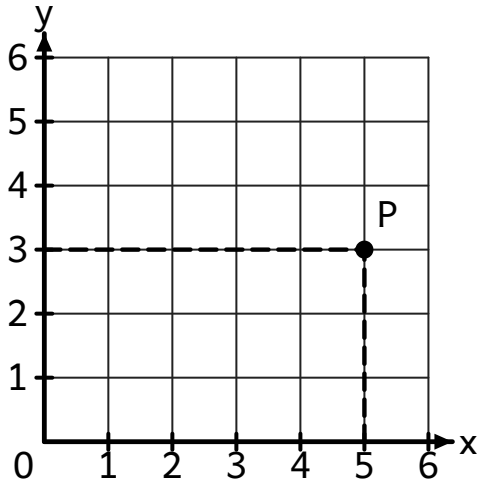
A point on the x axis has 0 up. A point on the y axis has 0 across.

WORKED EXAMPLE

Plot the point A (3, 5) on a grid.

1. The first number is 3. Start at the origin and go 3 across.
2. The second number is 5. Go 5 up from there.
3. Mark the dot. It is 3 across and 5 up.

Answer: 3 across and 5 up



Look down to the x axis for the first number. Look across to the y axis for the second.

WORKED EXAMPLE

Read the coordinates of the point P on the grid above.

1. Look straight down from P to the x axis. It meets the axis at 5.
2. Look straight across from P to the y axis. It meets the axis at 3.
3. Write across first: (5, 3).

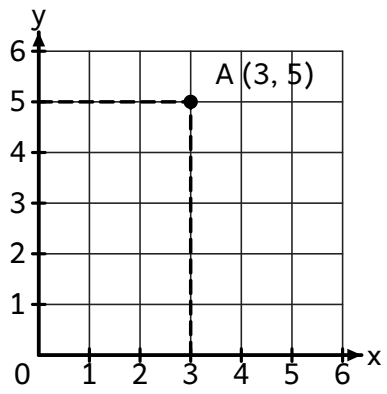
Answer: (5, 3)

SEE IT THREE WAYS

With things

Put a finger on the bottom left corner of squared paper. Move it 3 squares along. Then move it 5 squares up. Make a dot.

As a picture



In symbols

The place is written (3, 5). The first number is across and the second is up.

TRY IT

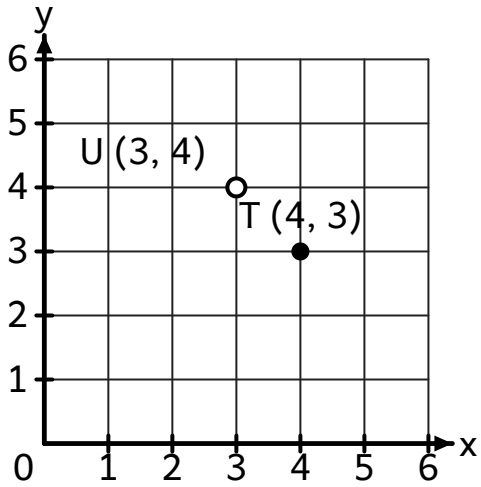
Hide a treasure on squared paper

You need: squared paper, a pencil, a friend.

1. Draw a line along the bottom of the paper and a line up the left side. Number each line 0, 1, 2, 3 and so on.
2. Mark a treasure on a crossing. Do not show your friend.
3. Tell your friend its coordinates, for example (4, 3).
4. Your friend marks the place. Then you compare the two papers.

What you will see: If your friend goes across first and then up, the two marks sit in the same place. If your friend goes up first, the marks are in different places. That is why everyone uses the same order.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~The order of the two numbers does not matter.~~

Why it feels right: Both numbers are in the brackets, so it seems they name the same place whichever comes first.

The test that breaks it: Plot (2, 5) and then (5, 2). Count across first, then up, each time. The dots are in different places.

What is true: The order matters. The first number is across and the second is up. Only a point with two equal numbers, like (4, 4), is the same both ways.

KEY WORDS

axis
a number line on a grid. The x axis goes across and the y axis goes up.

origin
the place where the two axes cross. Its coordinates are (0, 0).

coordinates
two numbers that name a place on a grid. Across comes first, then up.

plot
to mark a point on a grid.

BACK TO YOUR GUESS

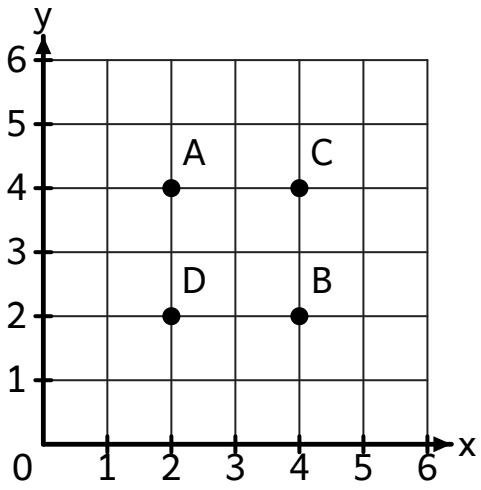
The answer is B: Go 3 across, then 5 up. The first number is how far across.

The first number tells how far across and the second tells how far up. So (3, 5) is 3 across and 5 up. The place (5, 3) is a different place: 5 across and 3 up.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which dot is the point (4, 2)?



A Dot A

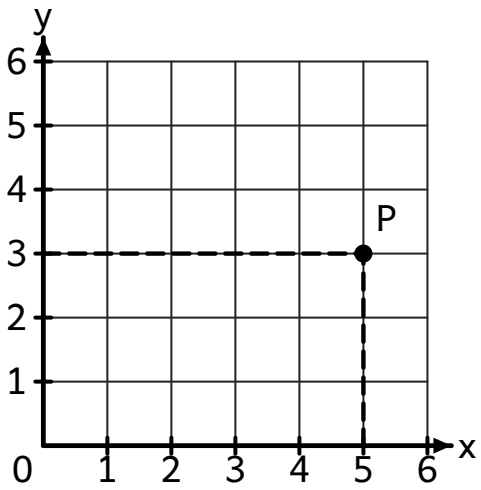
B Dot C

C Dot B

D Dot D

Answer at the back of the book.

2. What are the coordinates of the point P?



A (3, 5)

B (5, 5)

C (3, 3)

D (5, 3)

Answer at the back of the book.

3. Which sentence tells you how to plot the point (6, 1)?

   A Start at the origin. Go 1 across, then 6 up.

   B Start at the origin. Go 6 across, then 1 up.

   C Start anywhere on the grid. Go 6 across and 1 up.

   Answer at the back of the book.

4. The point (0, 4) is plotted. Where is it?

   A On the x axis, 4 across from the origin.

   B At the origin.

   C On the y axis, 4 up from the origin.

   Answer at the back of the book.

5. What are the coordinates of the origin?

   A (0, 0)

   B (1, 1)

   C (0, 1)

   Answer at the back of the book.

6. Mei walks 6 squares across and 2 squares up from the origin. What are her coordinates?

   Answer at the back of the book.

7. A point has coordinates (2, 6). How many units up is it from the x axis?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Coordinates are two numbers in brackets. The first is across and the second is up. Start at the origin, (0, 0). Across first, then up.

Draw: Draw a grid from 0 to 6. Plot (3, 5). Draw a dashed line down to the x axis and across to the y axis.

All four quarters of the grid

What if the place I want is to the left of the start, or below it?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The point (−2, 3) is in the same place as (2, 3). The minus sign changes nothing.
- ☐ **B** The point (−2, 3) is 2 to the left of the origin and 3 up.
- ☐ **C** The point (−2, 3) is 2 to the right of the origin and 3 down.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Negative numbers, factors and powers, M3.1.1. Negative numbers are the numbers left of 0 on a number line. They can go left or down on a grid.
- Level 2, Tables and charts, M2.7.6. A graph puts two number lines together.

BY THE END YOU CAN

- Plot points with negative coordinates, like (−2, 3)
- Find the fourth corner of a square from three corners

In the last chapter the grid had only numbers from 0 up. But a number line goes below 0 too. On a grid, the x axis goes left of the origin. The y axis goes down below it.

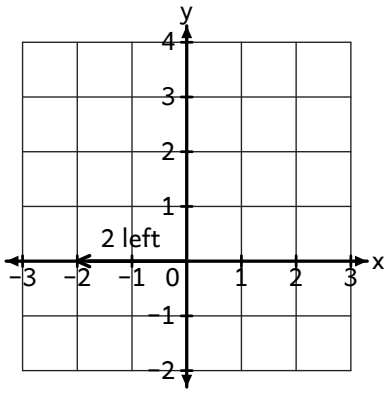
Left of 0 the numbers are −1, −2, −3 and so on. Below 0 the y axis goes −1, −2, −3 in the same way. So both axes have numbers on both sides of the origin.

The two axes cut the grid into four **quarters**. A negative across number sends you left. A negative up number sends you down.

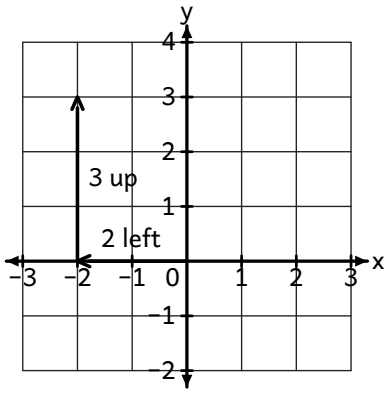
The first number of *a* point is its **x coordinate**. The second number is its **y coordinate**.

DRAW IT FIRST

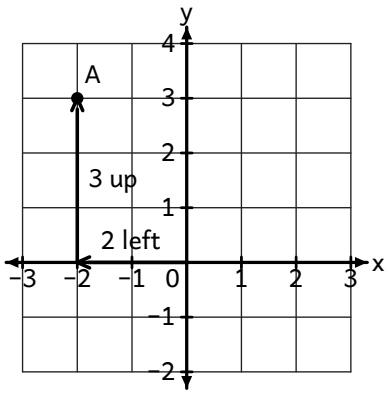
Plot the point (−2, 3)



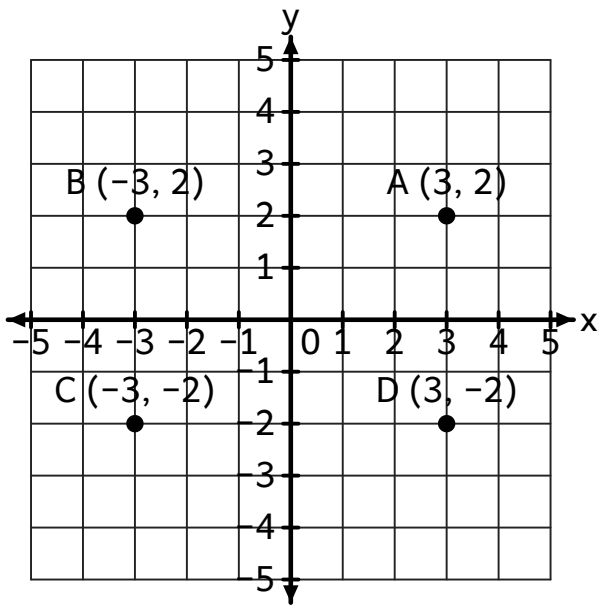
1 The first number is −2. A negative number means left. Go 2 left from the origin.



2 The second number is 3. A positive number means up. Go 3 up from there.



3 Mark *a* dot and write A. The point (−2, 3) is in the top left quarter.



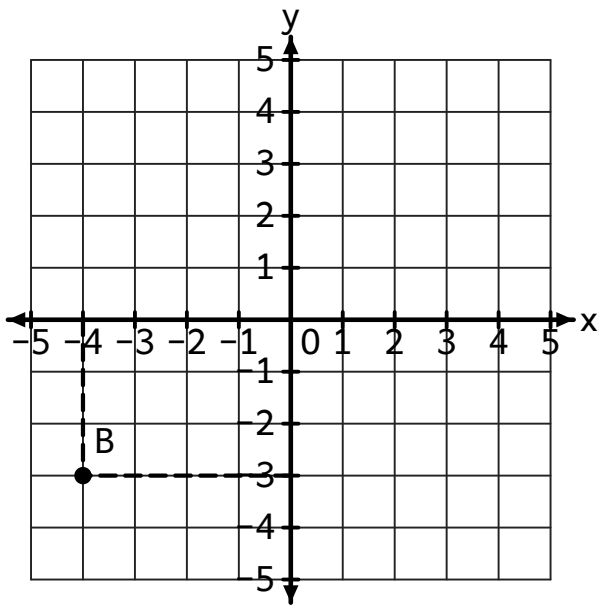
Top right: both numbers positive. Top left: across negative. Bottom left: both negative. Bottom right: up negative.

WORKED EXAMPLE

Plot the point B (−4, −3).

1. The first number is −4. Go 4 left from the origin.
2. The second number is −3. Go 3 down from there.
3. Mark the dot. It is in the bottom left quarter.

Answer: 4 left and 3 down



B is 4 left of the y axis and 3 below the x axis.

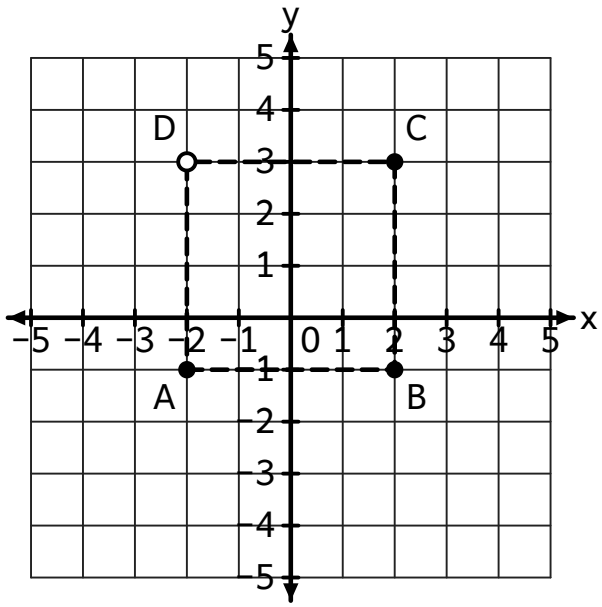
In this chapter the sides of the square run along the grid lines.

WORKED EXAMPLE

Three corners of a square are A (−2, −1), B (2, −1) and C (2, 3). Find the fourth corner D.

1. From A to B the square goes 4 across, from −2 to 2. So each side is 4 long.
2. From B to C it goes 4 up, from −1 to 3.
3. D is above A. It has the same across number as A, which is −2.
4. D has the same up number as C, which is 3. So D is (−2, 3).

Answer: (−2, 3)



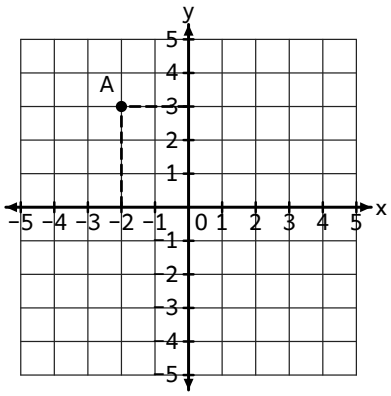
D is the open dot. Its across number matches A and its up number matches C.

SEE IT THREE WAYS

With things

Stand on a spot. Take 2 steps to the left. Then take 3 steps forward. Mark where you stop.

As a picture



In symbols

The place is (−2, 3). The first number is −2, so go left. The second number is 3, so go up.

TRY IT

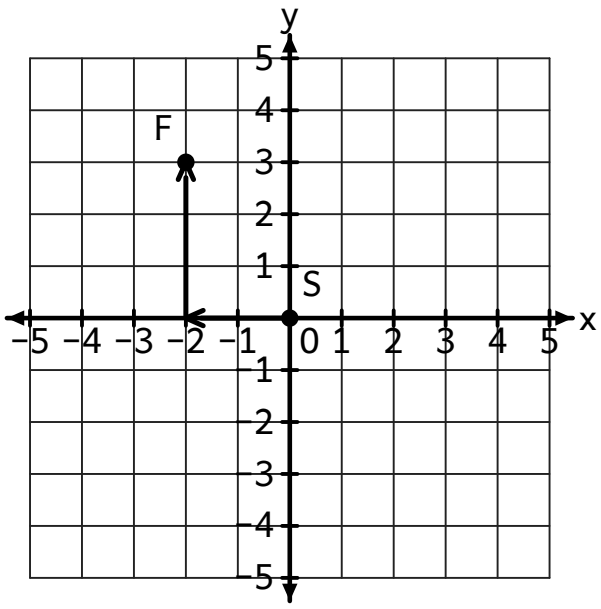
A floor grid

You need: chalk, or sticks and stones, a flat floor or yard, a friend.

1. Draw a long cross on the ground. The two lines are the axes. Mark the middle with a stone. This is the origin.
2. Mark every step along each line with a stone or a chalk mark. Count left of the middle as negative.
3. Your friend stands on the origin. Say a point, for example (−2, 3).
4. Your friend walks 2 steps left, then 3 steps forward. Check where they stop.

What you will see: A negative across number sends your friend left. A negative up number sends them back, towards the bottom of the picture. Forward is up.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~The point (−3, −2) is in the top right quarter, because two minus signs make a plus.~~

Why it feels right: Two minus signs do make a plus when you multiply negative numbers. So it seems both can cancel.

The test that breaks it: Plot (−3, −2). Go 3 left, then 2 down. You are in the bottom left quarter, not the top right.

What is true: The two numbers do not multiply. Each one moves the point by itself. A minus on the across number is left. A minus on the up number is down.

KEY WORDS

quarter
one of the four parts the two axes cut the grid into.

x coordinate
the first number of a point. It tells how far across, left or right.

y coordinate
the second number of a point. It tells how far up or down.

BACK TO YOUR GUESS

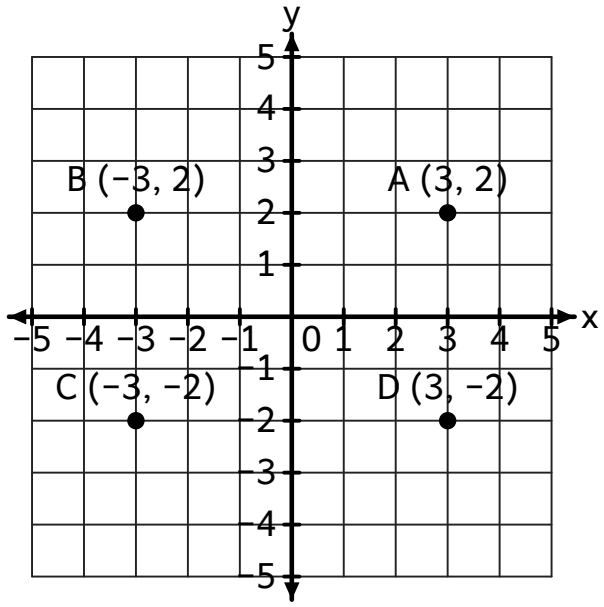
The answer is B: The point (−2, 3) is 2 to the left of the origin and 3 up.

A negative first number means left. A negative second number means down. So (−2, 3) is 2 left and 3 up. It is not the same place as (2, 3), which is 2 right and 3 up.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which point is in the bottom left quarter?



A Point A

B Point B

C Point C

D Point D

Answer at the back of the book.

2. Where is the point (−4, 2)?

A 4 right and 2 down

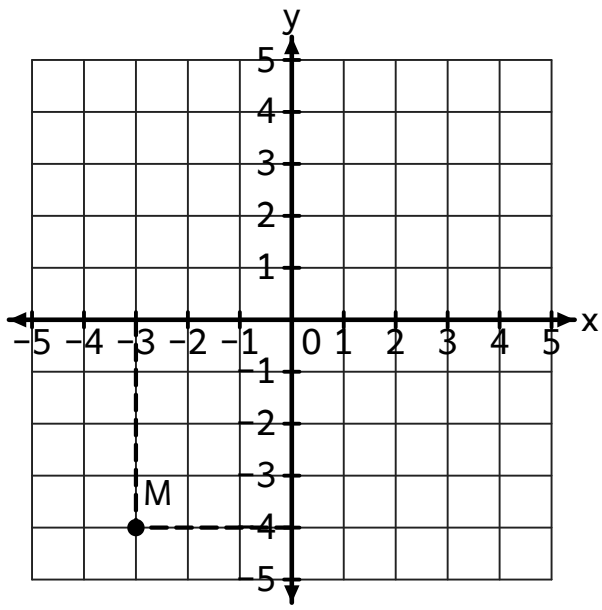
B 4 left and 2 up

C 4 left and 2 down

D 2 left and 4 up

Answer at the back of the book.

3. What are the coordinates of the point M?



A (3, 4)

B (−4, −3)

C (−3, 4)

D (−3, −4)

Answer at the back of the book.

4. Which point is on the y axis?

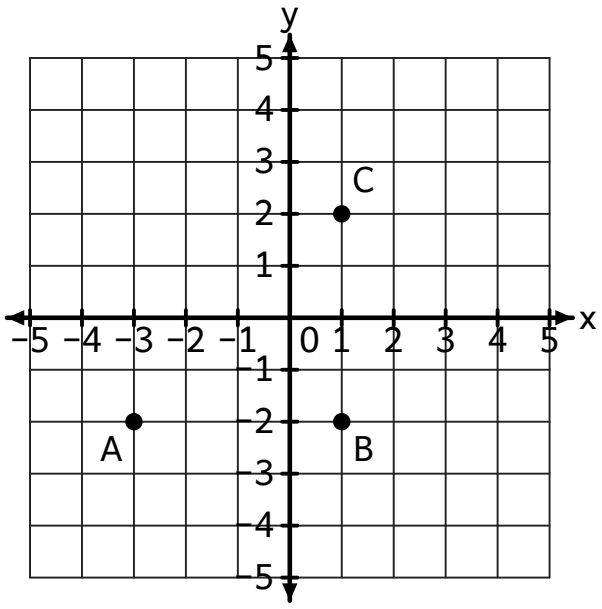
A (−3, 0)

B (−3, −3)

C (0, −3)

Answer at the back of the book.

5. Three corners of a square are A (−3, −2), B (1, −2) and C (1, 2). What is the fourth corner D?



A (−3, 2)

B (2, −3)

C (5, 2)

D (−3, −6)

Answer at the back of the book.

6. Three corners of a square are (−2, −2), (3, −2) and (3, 3). What is the fourth corner?

Answer at the back of the book.

7. How many units to the left of the y axis is the point (−4, 3)?

Answer at the back of the book.

8. **From an earlier chapter**

A point is 7 across and 2 up from the origin. What are its coordinates?

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Left of the origin is negative across. Below the origin is negative up. The axes make four quarters. Each number moves the point by itself.

Draw: Draw a grid from −5 to 5. Plot (−2, 3), (3, 2), (−3, −2) and (3, −2). Write each quarter next to its dot.

M3.9.3 CHAPTER 3

Shapes on a grid

If I slide a shape across a page, or flip it over, where do its corners go?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The point (3, 2) is reflected in the y axis. It goes to (3, −2).
- ☐ **B** The point (3, 2) is reflected in the y axis. It goes to (−3, 2).
- ☐ **C** The point (3, 2) is reflected in the y axis. It goes to (−3, −2).

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Coordinates and straight lines, M3.9.2. Shapes move into other quarters, so you need negative coordinates.
- Level 3, Negative numbers, factors and powers, M3.1.2. Moving a corner means adding negative numbers.

BY THE END YOU CAN

- Find the midpoint of a line between two points
- Move a shape on a grid by a translation
- Reflect a shape in the x axis or the y axis

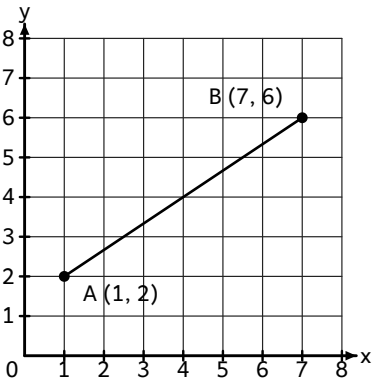
A shape on a grid is described by its corners. A triangle ABC has three corners, and each one has two coordinates. If you know the corners, you know the shape.

Three things can happen to a shape. We can find the middle of one of its lines. We can slide it. We can flip it. Each one changes the coordinates in a clear pattern.

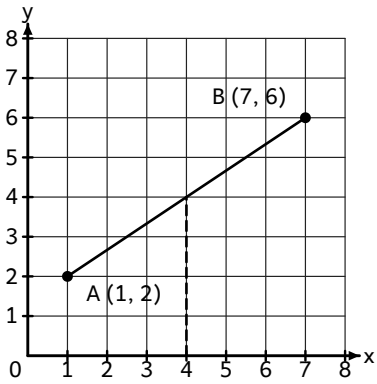
The **midpoint** of a line is the point exactly halfway along it. Add the two across numbers and halve the answer. Do the same with the two up numbers.

DRAW IT FIRST

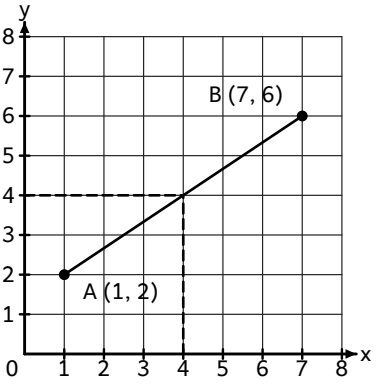
Find the midpoint of *a* line



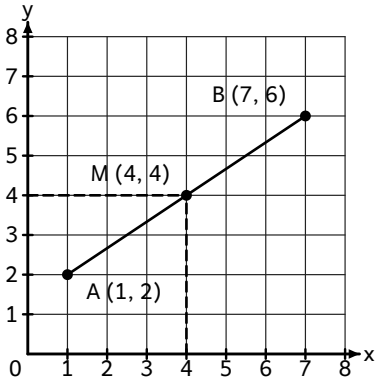
1 Join A (1, 2) and B (7, 6) with *a* straight line.



2 The across numbers are 1 and 7. Halfway is (1 + 7) ÷ 2 = 4.



3 The up numbers are 2 and 6. Halfway is (2 + 6) ÷ 2 = 4.



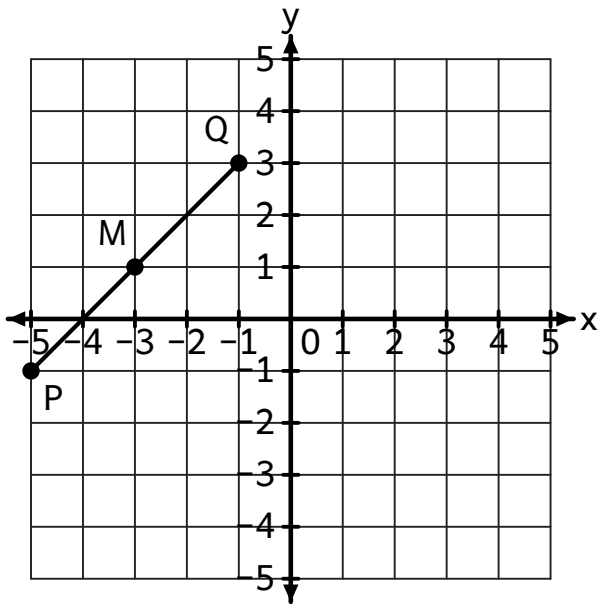
4 The midpoint M is (4, 4). It sits on the line, halfway from each end.

WORKED EXAMPLE

Find the midpoint of P (−5, −1) and Q (−1, 3).

1. Add the across numbers: −5 + (−1) = −6. Half of −6 is −3.
2. Add the up numbers: −1 + 3 = 2. Half of 2 is 1.
3. The midpoint is (−3, 1).

Answer: (−3, 1)

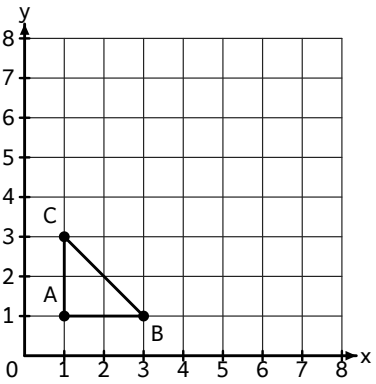


M is the same distance from P as from Q.

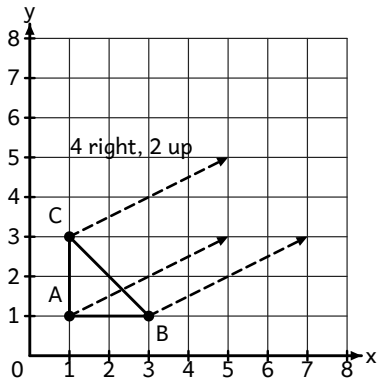
A **translation** slides every point of a shape the same distance in the same direction. We say it with two numbers: how far across and how far up. A negative number means left or down.

DRAW IT FIRST

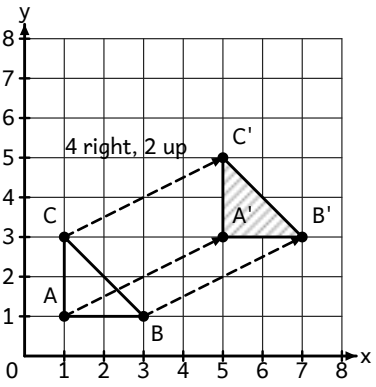
Slide a triangle 4 right and 2 up



1 Draw triangle ABC with corners (1, 1), (3, 1) and (1, 3).



2 Move every corner 4 right and 2 up. Draw an arrow from each corner. The arrows are all the same.



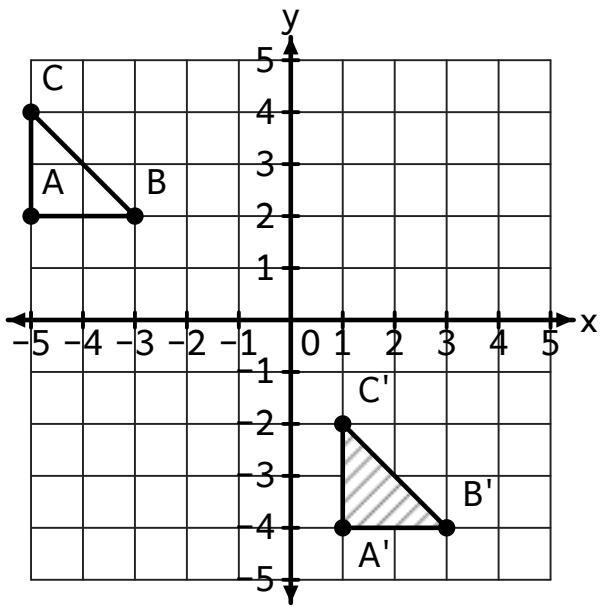
3 Join the new corners. The new triangle is the image. It is the same size and the same way up.

WORKED EXAMPLE

Slide the triangle with corners (−5, 2), (−3, 2), (−5, 4) by 6 right and 6 down.

1. Add 6 to every across number. Subtract 6 from every up number.
2. (−5, 2) goes to (1, −4). (−3, 2) goes to (3, −4).
3. (−5, 4) goes to (1, −2).
4. The image has corners (1, −4), (3, −4) and (1, −2).

Answer: (1, −4), (3, −4), (1, −2)

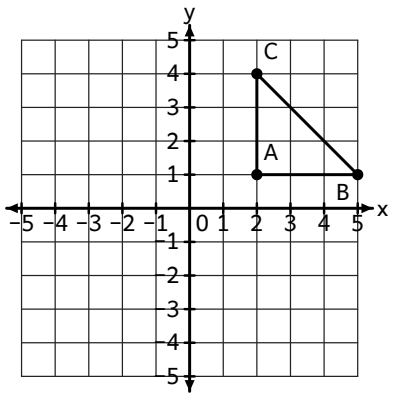


Every corner moves 6 right and 6 down.

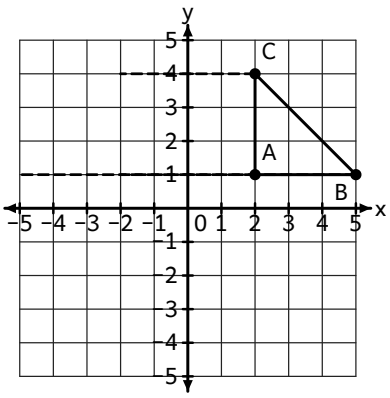
A **reflection** flips a shape over a mirror line. Each point goes to the other side of the mirror, the same distance away. The shape keeps its size but turns into its mirror image.

DRAW IT FIRST

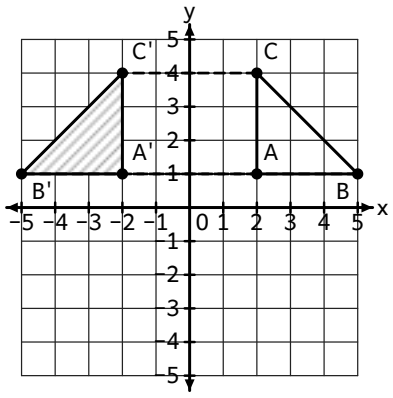
Reflect a triangle in the y axis



1 Draw triangle ABC on the right of the y axis. The y axis is the mirror.



2 From each corner draw a line straight across to the other side. The mirror cuts each line in half.



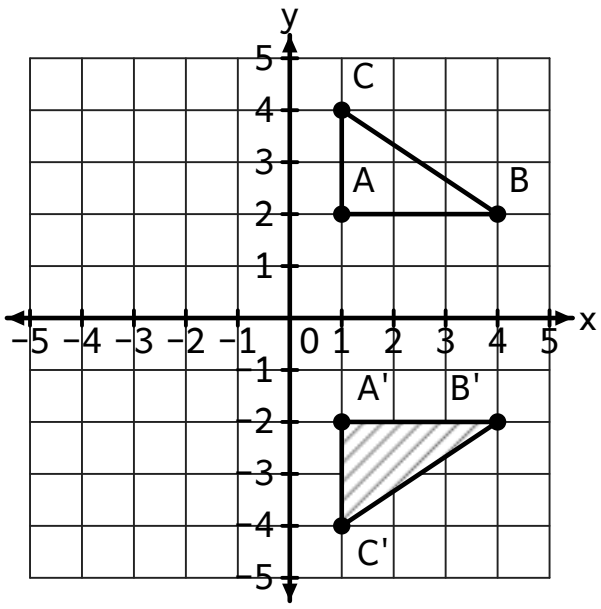
3 Mark each new corner as far from the mirror as the old one. Join them.

WORKED EXAMPLE

Reflect the triangle with corners (1, 2), (4, 2), (1, 4) in the x axis.

1. The x axis is the mirror, so each up number changes sign. The across numbers stay.
2. (1, 2) goes to (1, −2). (4, 2) goes to (4, −2).
3. (1, 4) goes to (1, −4).
4. Check one corner. (4, 2) is 2 above the x axis, and its image (4, −2) is 2 below it.
5. The image has corners (1, −2), (4, −2) and (1, −4).

Answer: (1, −2), (4, −2), (1, −4)



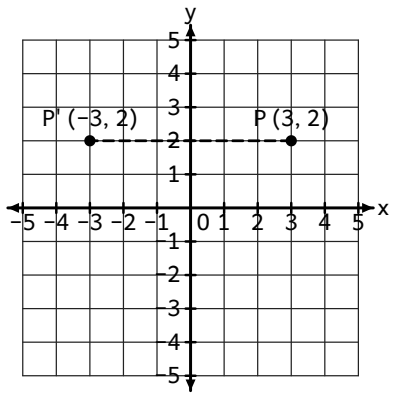
The x axis is the mirror. The across numbers stay and the up numbers change sign.

SEE IT THREE WAYS

With things

Fold squared paper along the y axis. Press a pin through the point (3, 2). Open the paper. There is a second hole.

As a picture



In symbols

In the y axis, the point (3, 2) goes to (−3, 2). The across number changes sign and the up number stays.

TRY IT

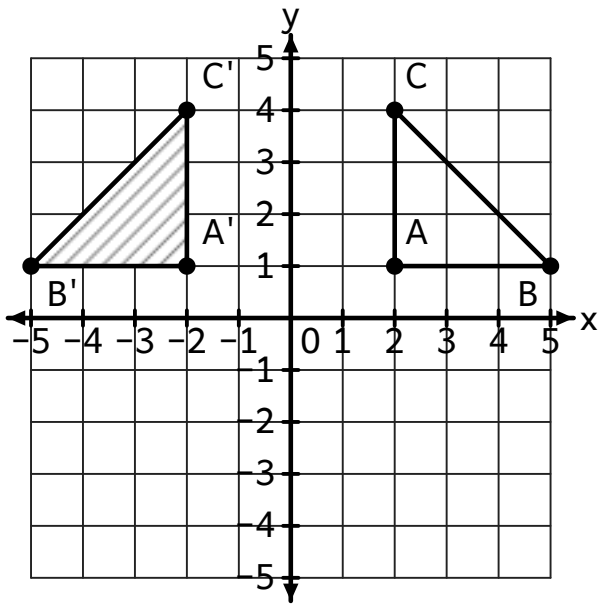
Fold and prick

You need: squared paper, a sharp pencil, a ruler.

1. Draw the two axes on squared paper. Plot a triangle with its corners on the right of the y axis.
2. Fold the paper along the y axis. Press the pencil point through each corner.
3. Open the paper. There are three new holes on the left.
4. Join the holes with a ruler. Write the coordinates of each corner.

What you will see: Each new corner is as far from the fold as the old one, on the other side. The up numbers stay and the across numbers change sign.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A reflection in the y axis changes the sign of both numbers.~~

Why it feels right: The point lands on the other side of the grid, so it seems that both numbers should change.

The test that breaks it: Reflect (3, 2) in the y axis. It stays 2 up. If both numbers changed, it would be (−3, −2), which is below the x axis. A mirror in the y axis does not turn a point upside down.

What is true: A reflection in the y axis changes only the sign of the across number. A reflection in the x axis changes only the sign of the up number.

KEY WORDS

midpoint
the point exactly halfway along a line.

translation
a slide. Every point moves the same distance in the same direction.

reflection
a flip over a mirror line. The image is the mirror image.

image
the shape after it has been moved.

BACK TO YOUR GUESS

The answer is B: The point (3, 2) is reflected in the y axis. It goes to (−3, 2).

The y axis is the mirror. A point stays the same height and lands on the other side of the mirror. So only the across number changes sign: (3, 2) goes to (−3, 2).

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What is the midpoint of (2, 6) and (8, 2)?

   A (10, 8)

   B (5, 4)

   C (6, −4)

   D (3, 2)

   Answer at the back of the book.

2. The point (3, 4) is moved 2 left and 5 down. Where does it go?

   A (5, 9)

   B (−2, −5)

   C (1, 9)

   D (1, −1)

   Answer at the back of the book.

3. The point (−3, 5) is reflected in the x axis. Where does it go?

   A (3, 5)

   B (3, −5)

   C (−3, −5)

   Answer at the back of the book.

4. A triangle and its image are mirror images in the y axis. The corner (3, 1) of the triangle matches which corner of the image?

   A (−3, 1)

   B (3, −1)

   C (−3, −1)

   Answer at the back of the book.

5. Which sentence is true about a translation?

   A Every point of the shape moves the same distance in the same direction.

   B The shape flips over a mirror line.

   C The corners move by different amounts.

   Answer at the back of the book.

6. Find the midpoint of (2, 3) and (6, 9).

   Answer at the back of the book.

7. Move the point (2, 3) by 4 right and 5 down. What are its new coordinates?

   Answer at the back of the book.

8. **From an earlier chapter**

   In which quarter of the grid is the point (−6, −1)?

   A Top right

   B Top left

   C Bottom left

   D Bottom right

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Midpoint: add the two numbers and halve, for across and for up. Translation: add the same numbers to every corner. Reflection in the x axis: up changes sign. In the y axis: across changes sign.

Draw: Draw a triangle on a grid. Slide it 3 right and 2 up. Then reflect it in the y axis. Label the corners.

M3.9.4 CHAPTER 4

From a rule to a line

A rule gives a y number for every x number. Can I draw the rule as a picture?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The points of y = 2x + 1 lie on a straight line.
- ☐ **B** The points of y = 2x + 1 make a curve that bends upwards.
- ☐ **C** The points of y = 2x + 1 are scattered with no pattern.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Letters for numbers and simple equations, M3.8.2. You put a number in place of x to find y.
- Level 2, Patterns and rules, M2.8.3. A rule is a number machine: x goes in and y comes out.

BY THE END YOU CAN

- Make a table of values for y = 2x + 1
- Plot the points and join them with a straight line

Here is a rule: y = 2x + 1. It says: double the number x, then add 1. The answer is y. Put in x = 3 and you get y = 2 × 3 + 1 = 7.

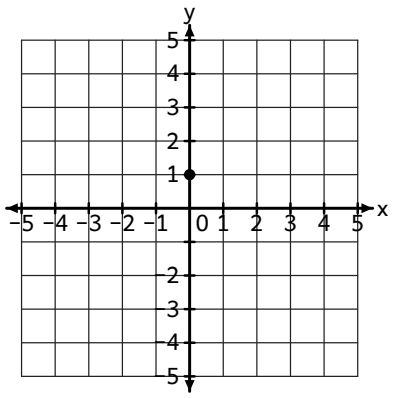
Each pair of x and y is a point. For x = 3 and y = 7, the point is (3, 7). A **table of values** lists several pairs, one in each row.

x	y = 2x + 1
−2	−3
−1	−1
0	1
1	3
2	5

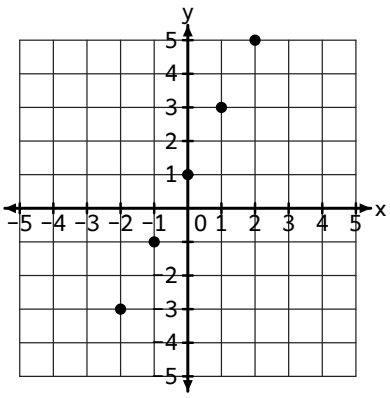
Each time x goes up by 1, y goes up by 2.

DRAW IT FIRST

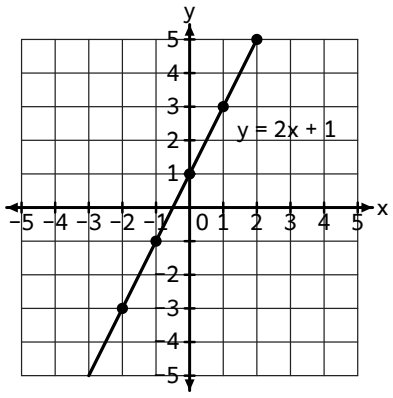
Draw the line y = 2x + 1



1 Start with x = 0. The rule gives y = 1, so plot (0, 1).



2 Work out y for the other x numbers in the table. Plot each point.



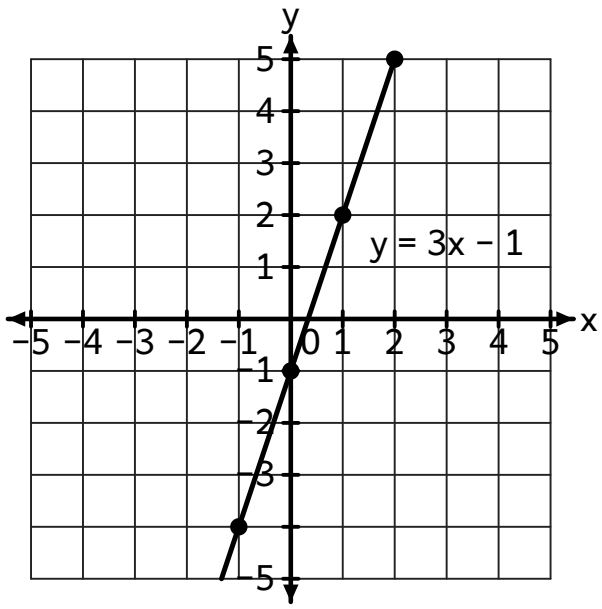
3 Lay a ruler along the points and draw the line. It goes on to the edge of the grid.

WORKED EXAMPLE

Make a table of values for y = 3x − 1 using x = −1, 0, 1 and 2.

1. For x = −1: y = 3 × (−1) − 1 = −3 − 1 = −4.
2. For x = 0: y = 3 × 0 − 1 = −1.
3. For x = 1: y = 3 × 1 − 1 = 2.
4. For x = 2: y = 3 × 2 − 1 = 5.

Answer: −4, −1, 2, 5



The four points lie on one straight line.

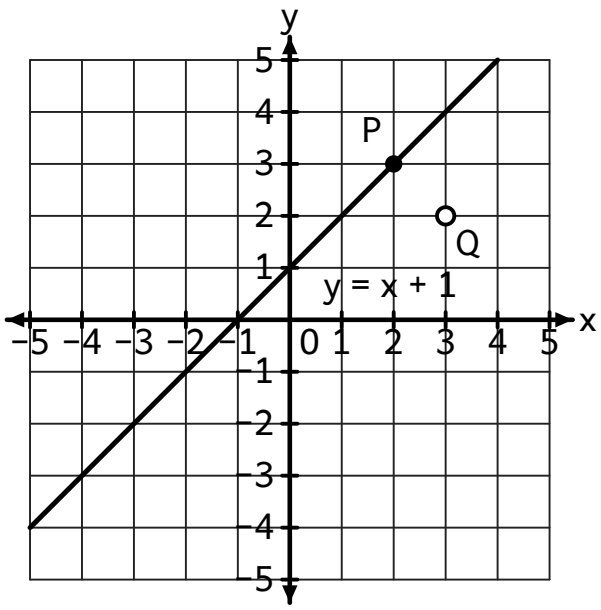
WORKED EXAMPLE

Plot the points of y = 3x − 1 and draw the line. Where does the line cross the y axis?

1. Plot the four points from the table: (−1, −4), (0, −1), (1, 2) and (2, 5).
2. Draw a straight line through them.
3. The line crosses the y axis where x = 0. The table says y = −1 there.
4. So the line crosses the y axis at (0, −1).

Answer: (0, −1)

The line goes on and on in both directions. Every point on it follows the rule, and every point that follows the rule is on it. A point off the line breaks the rule.



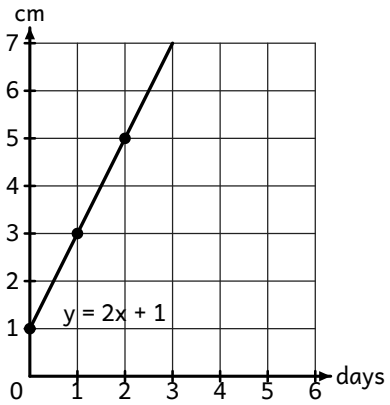
P is (2, 3) and Q is (3, 2). Put each point into the rule. P fits it. Q does not.

SEE IT THREE WAYS

With things

A seedling is 1 cm tall. It grows 2 cm every day. Measure it each morning.

As a picture



In symbols

y = 2x + 1, where x is the number of days and y is the height in cm.

TRY IT

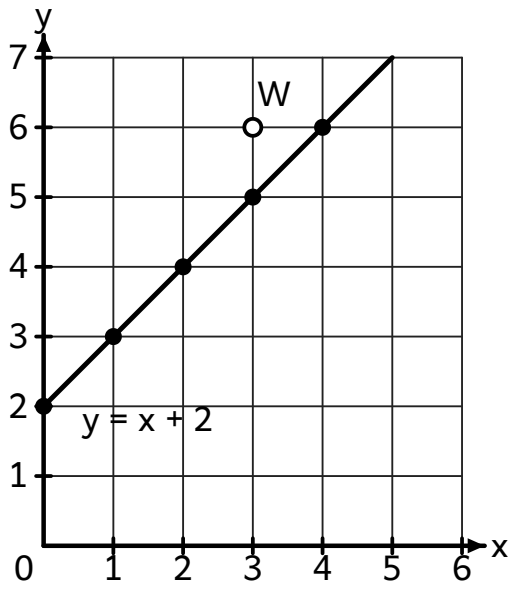
Catch a wrong point

You need: squared paper, a ruler, a pencil.

1. Draw the axes on squared paper, from 0 to 6 across and 0 to 6 up.
2. Take the rule y = x + 2. Make a table for x = 0, 1, 2, 3 and 4.
3. Plot the five points. Lay the ruler along them.
4. Change one answer in your table on purpose. Plot it and see what happens.

What you will see: The right points all lie on one straight line. A wrong point sits off the line. If a point looks off the line, check that sum again.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~The line stops at the last point you plotted.~~

Why it feels right: You only worked out a few points, so it seems the line should end there.

The test that breaks it: Put x = 10 into y = 2x + 1. You get y = 21. That is a point of the rule, far past the points in the table.

What is true: The rule works for every x, so its line goes on in both directions. Plot a few points to find the line, then draw it to the edge of the grid.

KEY WORDS

rule
a sentence with x and y, such as y = 2x + 1, that gives y for each x.

table of values
a list of x numbers with the y number that the rule gives for each.

BACK TO YOUR GUESS

The answer is A: The points of y = 2x + 1 lie on a straight line.

Each time x goes up by 1, y goes up by 2. Steps that are always the same make a straight line. The line goes on both ways, because the rule works for every x.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Work out y when x = 3 in the rule y = 2x + 1.

   A 6

   B 5

   C 7

   D 9

   Answer at the back of the book.

2. Work out y when x = −1 in the rule y = x − 3.

A −2

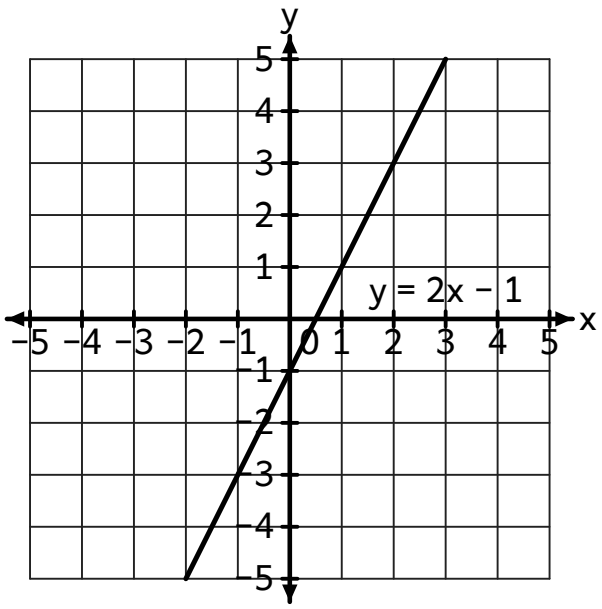
B −4

C 2

D 4

Answer at the back of the book.

3. The line y = 2x − 1 is drawn. Which of these points lies on it?



A (2, 5)

B (1, 2)

C (3, 4)

D (2, 3)

Answer at the back of the book.

4. Tariq made a table for $y = 2x + 1$. One of his points is wrong. Which one?

x	y = 2x + 1
0	1
1	3
2	5
3	8

A (2, 5)

B (3, 8)

C (0, 1)

D (1, 3)

Answer at the back of the book.

5. Where does the line $y = 3x - 1$ cross the y axis?

A (0, −1)

B (−1, 0)

C (0, 3)

D (1, 2)

Answer at the back of the book.

6. Work out y when $x = 3$ in the rule $y = 4x - 2$.

Answer at the back of the book.

7. A point on $y = x + 5$ has $x = -2$. What is its y number?

Answer at the back of the book.

8. **From an earlier chapter**

What is the midpoint of (0, 0) and (6, 4)?

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A rule gives y for each x. Make a table, plot the points, and draw a straight line through them. The line goes on both ways. A point off the line breaks the rule.

Draw: Draw a grid. Plot (0, 1), (1, 3) and (2, 5). Draw the line $y = 2x + 1$ through them with a ruler.

M3.9.5 CHAPTER 5

Lines like x = 3 and y = −2

> **What does a line look like when x is always 3? And where do two lines meet?**

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The line x = 3 is flat. It runs across the grid at 3 up.
- ☐ **B** The line x = 3 is upright. It goes up and down through 3 on the x axis.
- ☐ **C** The line x = 3 is slanted. It goes through (3, 3).

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Coordinates and straight lines, M3.9.4. You plot points of a rule and join them with a line.
- Level 3, Coordinates and straight lines, M3.9.2. Some points have negative numbers, such as (3, −2).

BY THE END YOU CAN

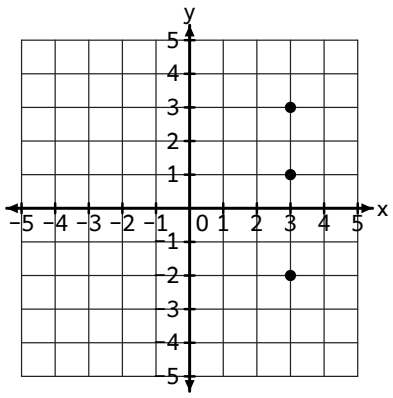
- Draw lines like x = 3 and y = −2
- Find where two straight lines cross

In the last chapter the rule gave a different y for each x. Now look at a rule with only one letter: x = 3. It says that x is 3 for every point. The y number can be anything.

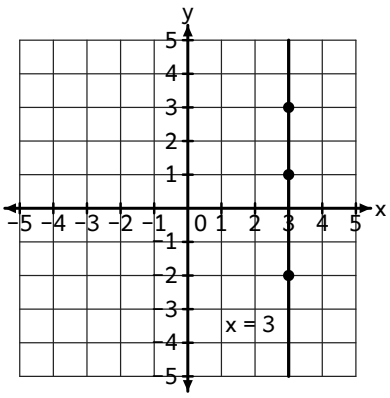
Think of the points (3, −2), (3, 1) and (3, 3). They all have x = 3. They sit one above the other, so they lie on an upright line. An upright line is **vertical**.

DRAW IT FIRST

Draw the line x = 3

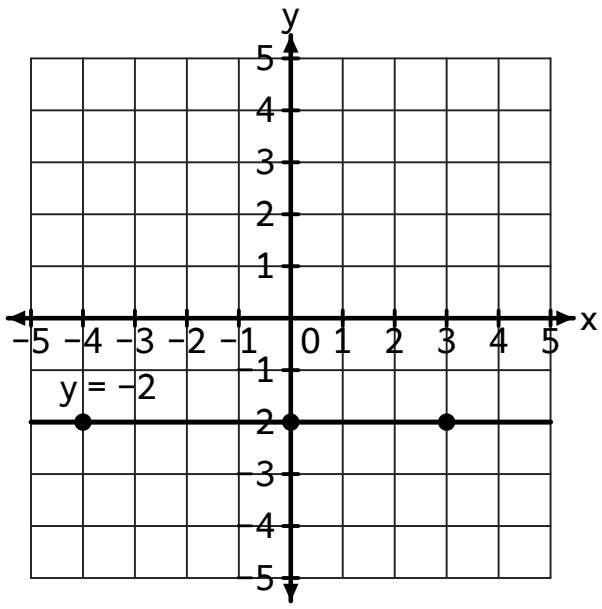


1 Pick some y numbers. Plot points that all have x = 3, such as (3, −2), (3, 1) and (3, 3).



2 Join them with a ruler. The line is upright and goes through 3 on the x axis. It goes on both ways.

Now take y = −2. Every point has y = −2, and x can be anything. The points (−4, −2), (0, −2) and (3, −2) lie side by side. They lie on a flat line. A flat line is **<u>horizontal</u>**.



All the points of y = −2 are 2 below the x axis.

WORKED EXAMPLE

Draw the line y = −2 and say where it crosses the y axis.

1. Every point has y = −2. Plot some, such as (−4, −2), (0, −2) and (3, −2).
2. Join them with a ruler. The line is flat.
3. The line crosses the y axis where x = 0. That is the point (0, −2).

Answer: (0, −2)

A way to remember. The line x = 3 stands on the 3 of the x axis, like a post. The line y = −2 lies at −2 on the y axis, like a shelf. The x axis is the line y = 0, and the y axis is the line x = 0.

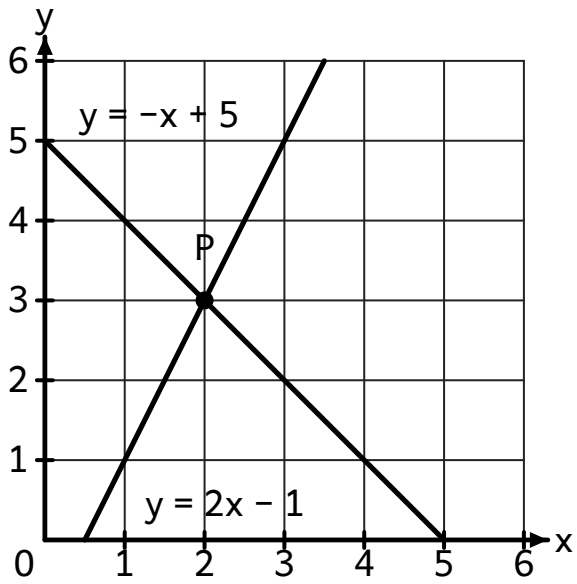
Two straight lines that do not run the same way cross at one point. To find it, draw both lines and read the place where they meet. Then check that point in both rules.

WORKED EXAMPLE

Find where the lines y = 2x − 1 and y = −x + 5 cross.

1. Draw both lines on the same grid. Make a table of values for each one.
2. They meet at the point (2, 3). Read it off the graph.
3. Check it in the first rule: 2 × 2 − 1 = 3. This agrees with y = 3.
4. Check it in the second rule: −2 + 5 = 3. This agrees with y = 3.

Answer: (2, 3)



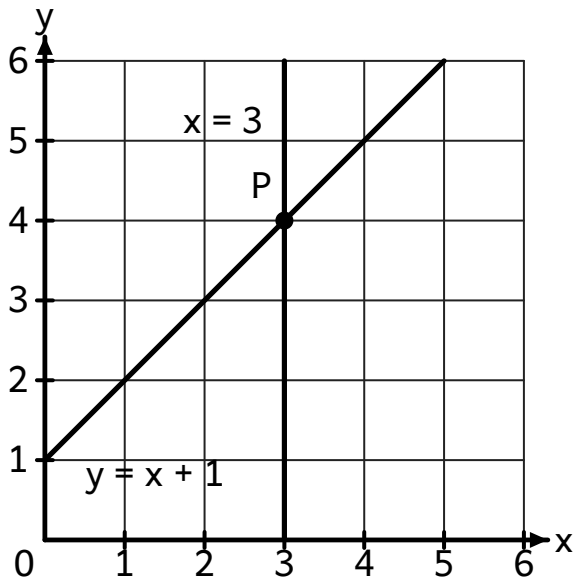
P is on both lines, so it fits both rules.

WORKED EXAMPLE

Find where the line y = x + 1 crosses the line x = 3.

1. Every point on x = 3 has x = 3.
2. Put x = 3 into the other rule: y = 3 + 1 = 4.
3. Check the point (3, 4) in the line x = 3. Its across number is 3.
4. The lines cross at (3, 4).

Answer: (3, 4)



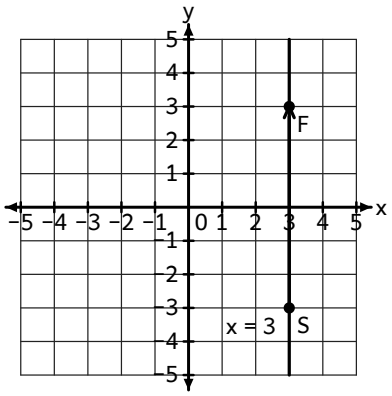
P is on both lines. It is the point (3, 4).

SEE IT THREE WAYS

With things

Stand on the 3 mark of a line on the ground. Walk straight forward. You stay on the 3 mark all the way.

As a picture



In symbols

x = 3 means every point has x = 3. The line is upright.

TRY IT

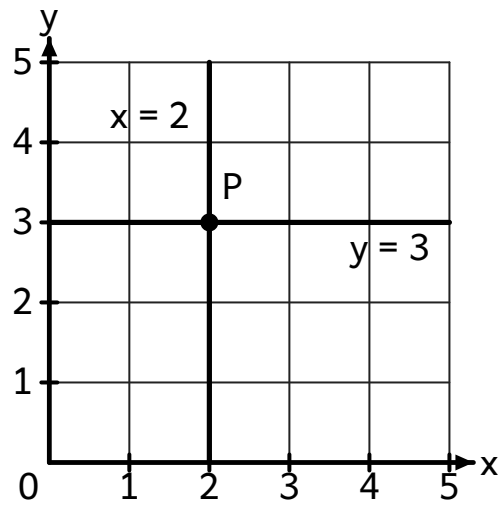
Where do two lines meet?

You need: squared paper, a ruler, a pencil.

1. Draw the axes on squared paper, from 0 to 5.
2. Draw the line x = 2 with a ruler. It goes up through 2 on the x axis.
3. Draw the line y = 3 across the paper through 3 on the y axis.
4. Mark the place where they cross. Read its two numbers.

What you will see: The lines cross at (2, 3). The upright line gives the across number and the flat line gives the up number.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~The line x = 3 is flat, because the x axis is flat.~~

Why it feels right: The x axis goes across, so a rule with x in it seems to go across too.

The test that breaks it: Plot three points with x = 3, such as (3, −2), (3, 1) and (3, 4). They are one above the other, so the line goes up.

What is true: The line x = a is upright. The line y = b is flat. Look at the letter. The rule x = 3 fixes where you stand on the x axis. So the line goes up and down.

KEY WORDS

vertical
upright, going straight up and down. The line x = 3 is vertical.

horizontal
flat, going straight across. The line y = −2 is horizontal.

BACK TO YOUR GUESS

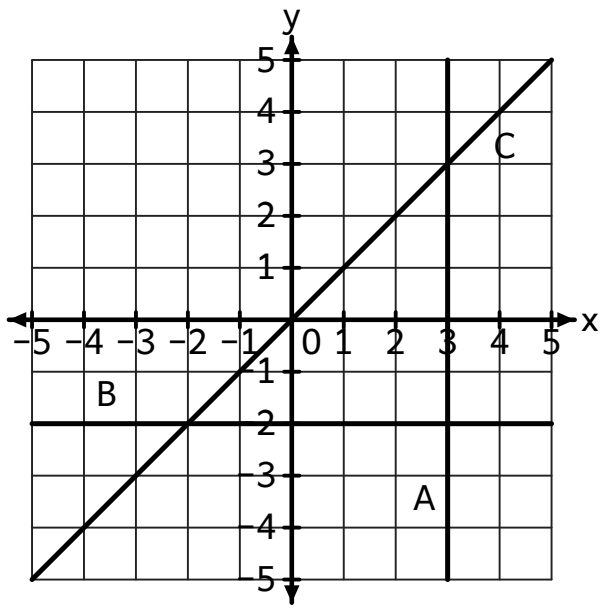
The answer is B: The line x = 3 is upright. It goes up and down through 3 on the x axis.

On the line x = 3 every point has x = 3, and y can be any number. The points (3, −2), (3, 1) and (3, 4) are stacked one above the other. So the line is upright.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which line is x = 3?



A Line B

B Line A

C Line C

Answer at the back of the book.

2. The line y = −2 is drawn. What does it look like?

A An upright line, 2 to the left of the y axis.

B A flat line, 2 above the x axis.

C A flat line, 2 below the x axis.

Answer at the back of the book.

3. Which point is on the line x = 4?

A (−1, 4)

B (−4, −1)

C (4, −1)

D (−4, 4)

Answer at the back of the book.

4. The lines x = 2 and y = 5 cross. At which point?

   A (5, 2)

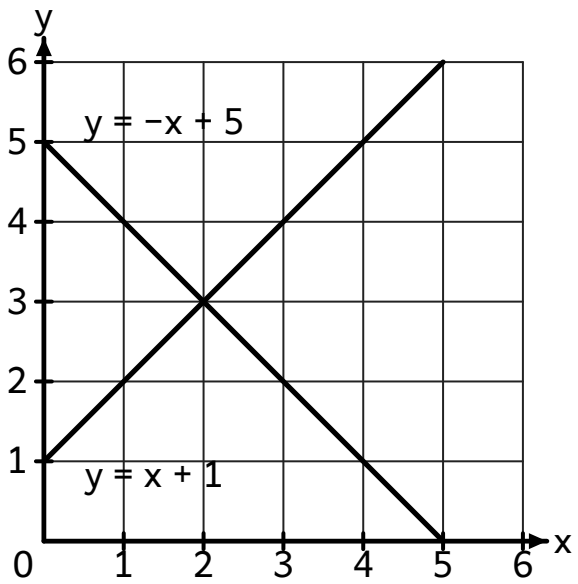
   B (2, 5)

   C (2, 2)

   D (5, 5)

   Answer at the back of the book.

5. Where do these two lines cross?



   A (2, 3)

   B (3, 2)

   C (0, 1)

   D (0, 5)

   Answer at the back of the book.

6. Where do the lines x = 3 and y = x + 2 cross?

   Answer at the back of the book.

7. Where do the lines y = 4 and y = x + 1 cross?

   Answer at the back of the book.

8. **From an earlier chapter**

Work out y when x = −2 in the rule y = 3x + 1.

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

The line x = 3 is vertical, through 3 on the x axis. The line y = −2 is horizontal, through −2 on the y axis. Two lines that are not parallel cross at one point. That point fits both rules.

Draw: Draw a grid. Draw the lines x = 3 and y = −2 with a ruler. Mark where they cross and write its coordinates.

M3.9.6 CHAPTER 6

Steepness: the gradient

How steep is a line? Can I put a number on it?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** A line rises 4 while it runs 2 across. Its steepness is 2.
- ☐ **B** A line rises 4 while it runs 2 across. Its steepness is 6.
- ☐ **C** A line rises 4 while it runs 2 across. Its steepness is 0.5.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Coordinates and straight lines, M3.9.4. You need to draw a line from its rule.
- Level 3, Ratio and proportion, M3.4.6. A gradient is a rate: how much it goes up for each step across.

BY THE END YOU CAN

- Find the gradient of a line from two points on it
- Say how the number in front of x changes the line

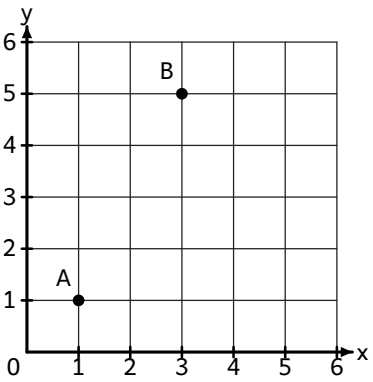
A hill can be gentle or steep. We can put a number on how steep a straight line is. The number is called its **gradient**.

Pick two points on a line. Go across from the first to the second. That distance across is the **run**. Then go up. That distance up is the **rise**.

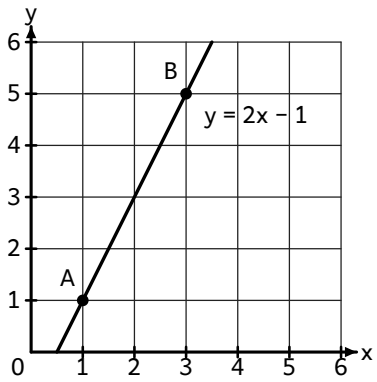
The gradient is the rise divided by the run. A steep line rises a lot for each step across, so its gradient is big. A gentle line has a small gradient.

DRAW IT FIRST

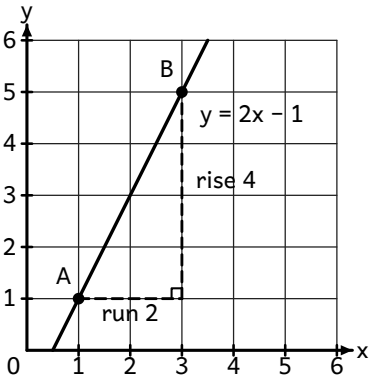
Find the gradient of a line



1 Choose two points on the line. Here they are A (1, 1) and B (3, 5).



2 Draw the line through them with a ruler.



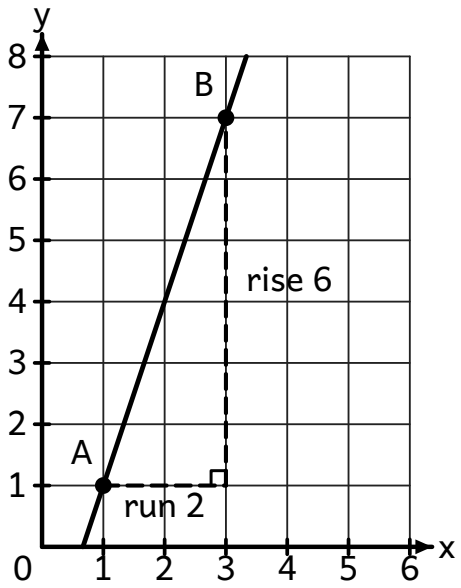
3 From A go 2 across, then 4 up to B. The run is 2 and the rise is 4. The gradient is 4 ÷ 2 = 2.

WORKED EXAMPLE

Find the gradient of the line through (1, 1) and (3, 7).

1. Find the run. Going from 1 to 3 across, the run is 3 − 1 = 2.
2. Find the rise. Going from 1 to 7 up, the rise is 7 − 1 = 6.
3. The gradient is the rise divided by the run: 6 ÷ 2 = 3.

Answer: 3



The run is 2 and the rise is 6. The gradient is 6 ÷ 2 = 3.

Now a line that goes down as you move to the right. Going from the first point to the second, the rise is negative, because you go down. So its gradient is negative.

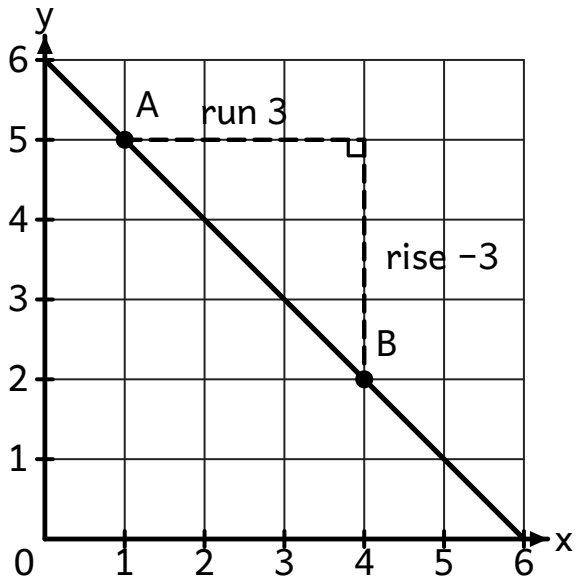
WORKED EXAMPLE

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

1. Find the run. Going from 1 to 4 across, the run is 4 − 1 = 3.
2. Find the rise. The up number goes from 5 to 2, so the rise is 2 − 5 = −3. The line goes down.
3. The gradient is −3 ÷ 3 = −1.

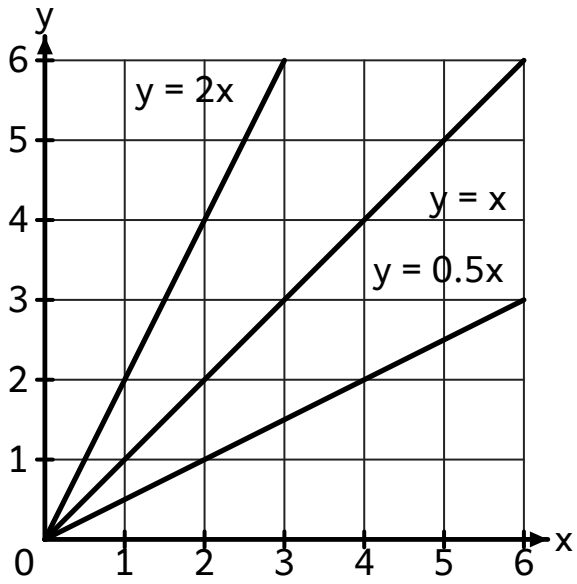
Answer: −1

A flat line has a rise of 0, so its gradient is 0 ÷ run = 0. An upright line has no run, so it has no gradient.



The line goes down to the right, so the gradient is negative.

Now look at the rule. In y = 2x, the number in front of x is 2. It is the gradient. In y = 3x it is 3. For lines that go up to the right, a bigger number is steeper. For any line, the bigger the number without its sign, the steeper the line. A negative number gives a line that goes down to the right.



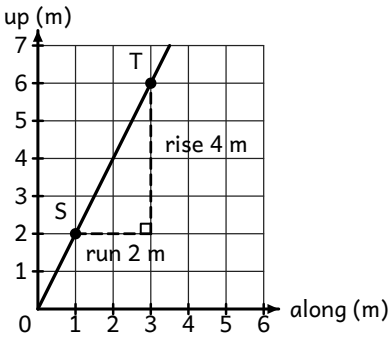
For lines that go up, the bigger the number in front of x, the steeper the line.

SEE IT THREE WAYS

With things

A steep bank rises 4 m for every 2 m along the ground. Walk up it and feel how steep it is.

As a picture



In symbols

The gradient is 4 ÷ 2 = 2. The bank rises 2 m for every 1 m along.

TRY IT

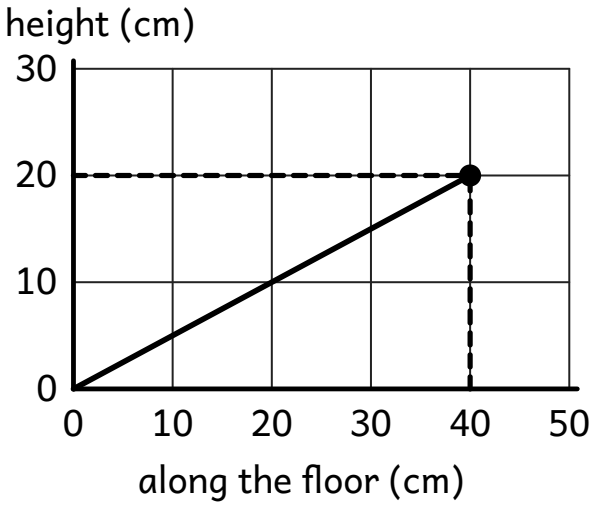
Measure the steepness of a plank

You need: a plank or a flat board, some books, a ruler.

1. Rest one end of the plank on a stack of books. The other end stays on the floor.
2. Measure how high the top end is above the floor. This is the rise.
3. Measure along the floor from the bottom end to the point just under the top end. This is the run.
4. Divide the rise by the run. Then make the stack taller and measure again.

What you will see: A taller stack gives a bigger rise, so a bigger gradient. The plank is steeper. A rise of 20 cm over a run of 40 cm gives a gradient of 0.5.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~The gradient is the run divided by the rise.~~

Why it feels right: In a coordinate pair the across number comes first, so it seems we should divide across by up.

The test that breaks it: A steep line rises 6 while it runs 1. Run ÷ rise would give 1 ÷ 6, a small number. But a steep line should have a big gradient.

What is true: The gradient is the rise divided by the run. Up divided by across. A steeper line has a bigger gradient.

KEY WORDS

gradient
how steep a line is. It is the rise divided by the run.

rise
how far up you go between two points. It is negative if you go down.

run
how far across you go between two points.

BACK TO YOUR GUESS

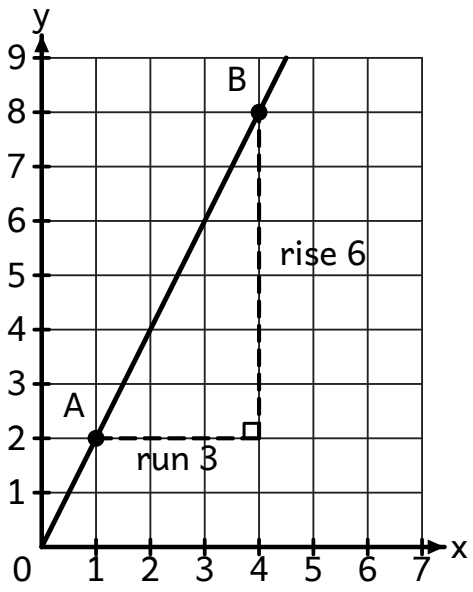
The answer is A: A line rises 4 while it runs 2 across. Its steepness is 2.

The steepness of a line is called its gradient. It is the rise divided by the run. Here 4 ÷ 2 = 2. The number 0.5 is the run divided by the rise, which is the wrong way round.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What is the gradient of the line through (1, 2) and (4, 8)?



A 0.5

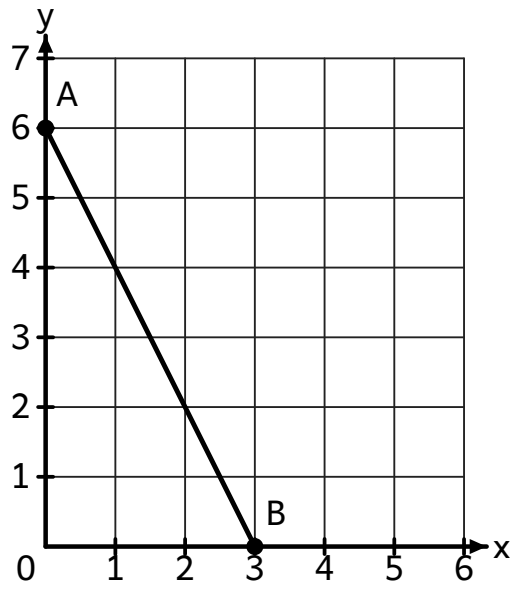
B 9

C 6

D 2

Answer at the back of the book.

2. What is the gradient of the line through (0, 6) and (3, 0)?



A −2

B 2

C −0.5

D 3

Answer at the back of the book.

3. Which of these lines is the steepest?

A $y = x + 8$

B $y = 3x + 4$

C $y = 5x - 1$

D $y = 2x$

Answer at the back of the book.

4. A line goes down as you move to the right. What can you say about its gradient?

A It is negative.

B It is positive.

C It is zero.

Answer at the back of the book.

5. What is the gradient of the line $y = -2x + 3$?

   A -2

   B 3

   C 2

   D -3

   Answer at the back of the book.

6. What is the gradient of the flat line $y = 4$?

   A 4

   B 0

   C It has no gradient.

   Answer at the back of the book.

7. Find the gradient of the line through (1, 2) and (4, 11).

   Answer at the back of the book.

8. A steep slope rises 12 m while it runs 4 m along the ground. What is its gradient?

   Answer at the back of the book.

9. **From an earlier chapter**

   Where do the lines $x = 2$ and $y = 6$ cross?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Gradient = rise ÷ run. A line going up to the right has a positive gradient. A line going down has a negative one. In y = mx + c the number in front of x is the gradient.

Draw: Draw a line through (1, 1) and (3, 5). Draw the step triangle. Write run 2, rise 4 and gradient 2.

M3.9.7 CHAPTER 7

The equation y = mx + c

Can I see how steep a line is, and where it crosses, from its rule alone?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The line y = 3x − 2 crosses the y axis at the point (0, 3).
- ☐ **B** The line y = 3x − 2 crosses the y axis at the point (0, −2).
- ☐ **C** The line y = 3x − 2 crosses the y axis at the point (−2, 0).

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Coordinates and straight lines, M3.9.6. You need to find the gradient from rise and run.
- Level 3, Letters for numbers and simple equations, M3.8.2. You put x = 0 into a rule to find where the line crosses the y axis.

BY THE END YOU CAN

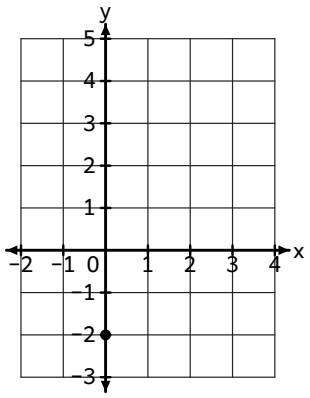
- Find the gradient of y = 3x − 2 from its equation
- Find where y = 3x − 2 crosses the y axis
- Write the equation of a line from its graph

Every straight line that is not upright has a rule that looks like this: y = mx + c. The letters m and c stand for two numbers. They tell you almost everything about the line.

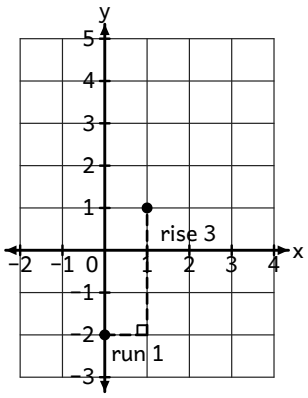
The number m is in front of x. It is the **gradient**, how steep the line is. The number c stands alone. It is where the line crosses the y axis. This crossing point is the **y intercept**, the point (0, c).

DRAW IT FIRST

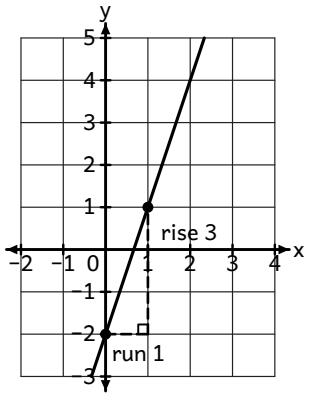
Draw the line y = 3x − 2 from m and c



1 The number on its own is c = −2. Plot the point (0, −2) on the y axis.



2 The gradient is m = 3. That is 3 up for 1 across. From (0, −2) go 1 across and 3 up. Plot (1, 1).



3 Draw the line through the two points. It is the line y = 3x − 2.

WORKED EXAMPLE

Find the gradient of y = 3x − 2 and where it crosses the y axis.

1. Compare the rule with y = mx + c. The number in front of x is 3, so m = 3.
2. The number on its own is −2, so c = −2.
3. The gradient is 3. The line crosses the y axis at (0, −2).

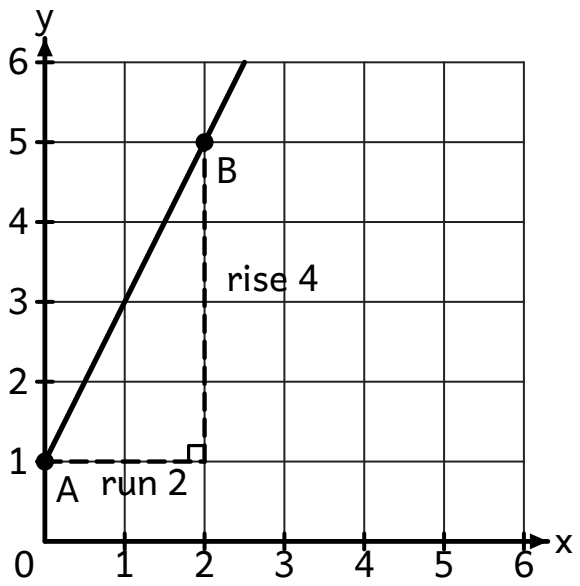
Answer: 3 and −2

WORKED EXAMPLE

A line goes through (0, 1) and (2, 5). Write its equation.

1. The line crosses the y axis at (0, 1), so c = 1.
2. From (0, 1) to (2, 5) the run is 2 and the rise is 4.
3. The gradient is 4 ÷ 2 = 2, so m = 2.
4. Put m and c into y = mx + c. The equation is y = 2x + 1.

Answer: y = 2x + 1



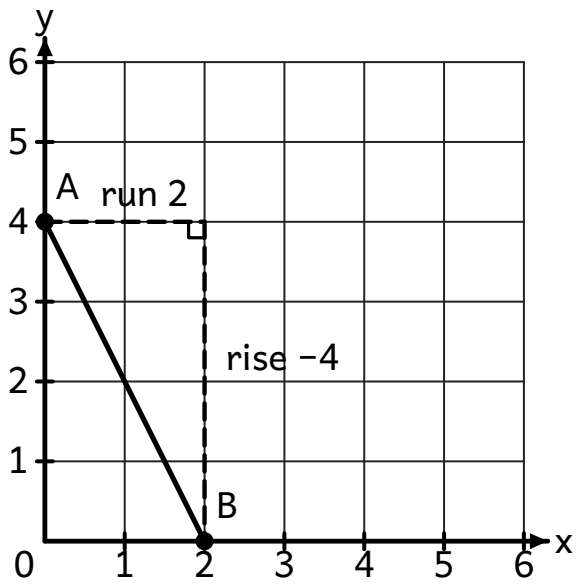
A is where the line crosses the y axis. The step triangle gives the gradient.

WORKED EXAMPLE

A line goes through (0, 4) and (2, 0). Write its equation.

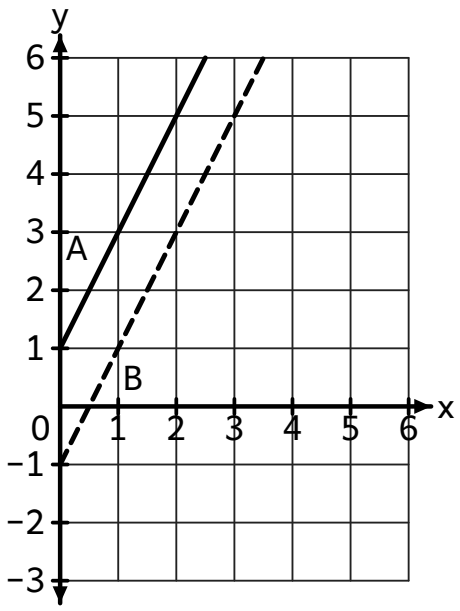
1. The line crosses the y axis at (0, 4), so c = 4.
2. From (0, 4) to (2, 0) the run is 2 and the rise is −4. The line goes down.
3. The gradient is −4 ÷ 2 = −2, so m = −2.
4. The equation is y = −2x + 4.

Answer: y = −2x + 4



The line goes down to the right, so m is negative.

Now see what c does. Two lines with the same m but different c have the same steepness. They never meet. We say they are **parallel**. Changing c moves a line up or down, and does not turn it.



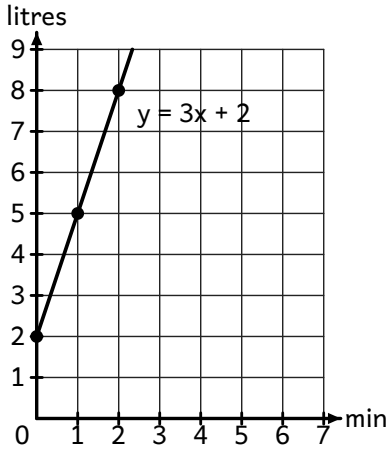
Line A is y = 2x + 1. Line B is y = 2x − 1. Both have m = 2. They are parallel, and A is 2 above B.

SEE IT THREE WAYS

With things

A tank holds 2 litres at the start. A tap adds 3 litres every minute.

As a picture



In symbols

y = 3x + 2, where x is the minutes and y is the litres. The gradient 3 is the litres added each minute. The 2 is the litres at the start.

TRY IT

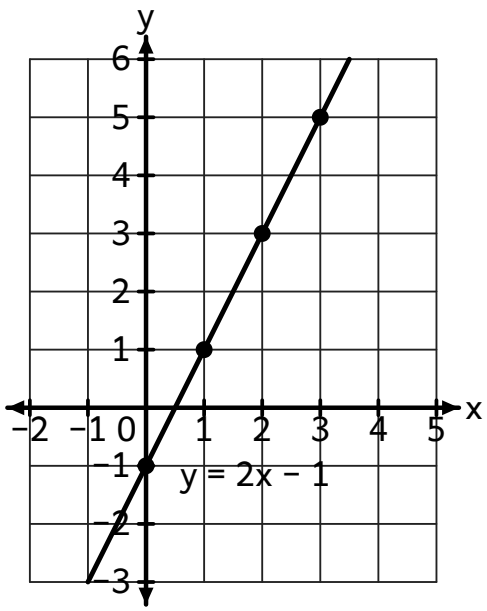
Draw a line from m and c

You need: squared paper, a ruler, a pencil.

1. Draw the axes on squared paper, from −5 to 5.
2. Take the rule y = 2x − 1. Plot (0, −1) on the y axis, because c = −1.
3. The gradient is 2. From the dot go 1 across and 2 up. Plot the new dot. Do it again.
4. Lay the ruler along the dots and draw the line. Check that (3, 5) is on it.

What you will see: You do not need a table of values. The number c gives the start. The number m gives each step. Putting x = 3 into the rule gives y = 5, so the line passes through (3, 5).

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~**The line y = 3x − 2 crosses the y axis at 3.**~~

Why it feels right: The 3 is the first number you see. So it seems to be the starting point.

The test that breaks it: The y axis is where x = 0. Put x = 0 into y = 3x − 2. Then y = 3 × 0 − 2 = −2. The line crosses at (0, −2), not at 3.

What is true: The number in front of x is the gradient. The number on its own is where the line crosses the y axis. In y = 3x − 2 they are 3 and −2.

KEY WORDS

y intercept
the point where a line crosses the y axis. In y = mx + c it is (0, c).

parallel
lines with the same gradient. They never meet.

BACK TO YOUR GUESS

The answer is B: The line y = 3x − 2 crosses the y axis at the point (0, −2).

On the y axis x is 0. Put x = 0 into y = 3x − 2 and you get y = −2. So the line crosses at (0, −2). The number on its own, here −2, tells where the line crosses the y axis.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What is the gradient of the line y = 3x − 2?

   A −2

   B 2

   C 3

   D 1

   Answer at the back of the book.

2. Where does the line y = 3x − 2 cross the y axis?

   A (0, −2)

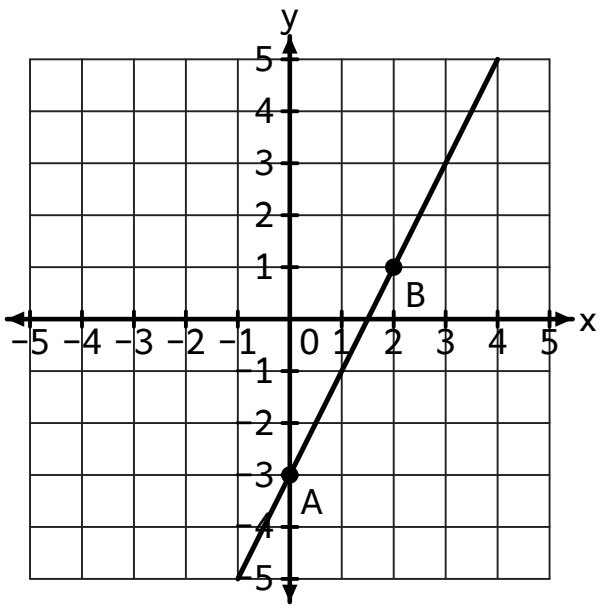
   B (0, 3)

   C (−2, 0)

   D (0, 2)

   Answer at the back of the book.

3. Which equation is the line through A and B?



   A y = 2x + 3

   B y = −3x + 2

   C y = 4x − 3

   D y = 2x − 3

   Answer at the back of the book.

4. Which line is parallel to $y = 4x + 1$?

   A $y = x + 4$

   B $y = 4x - 5$

   C $y = 5x + 1$

   Answer at the back of the book.

5. The line $y = -x + 4$ is drawn. What does it do?

   A It goes up to the right and crosses the y axis at 4.

   B It goes down to the right and crosses the y axis at −1.

   C It goes down to the right and crosses the y axis at 4.

   Answer at the back of the book.

6. A line goes through (0, 4) and (2, 10). What is its gradient?

   Answer at the back of the book.

7. The line $y = 4x - 6$ crosses the y axis. What is its y number there?

   Answer at the back of the book.

8. **From an earlier chapter**

   What is the gradient of the line through (2, 1) and (5, 10)?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

$y = mx + c$. The number m in front of x is the gradient. The number c on its own is where the line crosses the y axis, at (0, c). Parallel lines have the same m.

Draw: Draw the line $y = 2x + 1$. Plot (0, 1). Go 1 across and 2 up. Plot a dot. Join them. Write m and c next to the line.

M3.9.8 CHAPTER 8

Graphs from real life

Can a graph tell the story of a walk?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** A flat part of a distance time graph means the person is going very fast.
- ☐ **B** A flat part of a distance time graph means the person has stopped.
- ☐ **C** A flat part of a distance time graph means the person is walking downhill.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Ratio and proportion, M3.4.5. A straight line through (0, 0) shows direct proportion.
- Level 2, Tables and charts, M2.7.6. You read values from a line graph that shows change over time.
- Level 3, Coordinates and straight lines, M3.9.6. On a distance time graph the gradient is the speed.

BY THE END YOU CAN

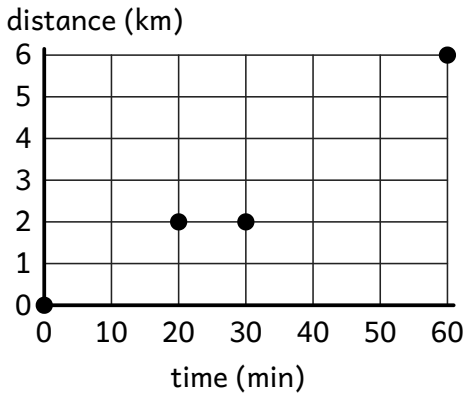
- Draw and read a distance time graph of a walk
- Explain what a flat part of a travel graph means
- Spot direct proportion as a straight line through (0, 0)

A **distance time graph** tells the story of a journey. Time goes across, in minutes or hours. Distance from the start goes up, in km. Both axes start at 0.

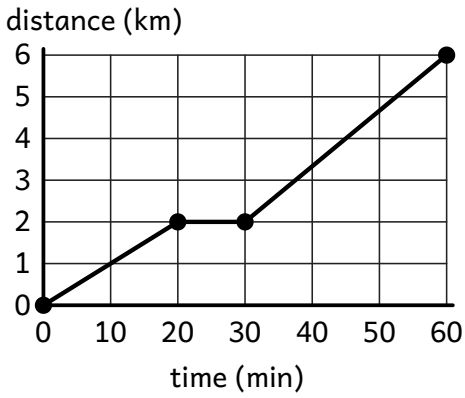
Amina walks to a spring. She walks 2 km in the first 20 minutes. She rests for 10 minutes. Then she walks 4 km more in 30 minutes. Here is her walk as a graph.

DRAW IT FIRST

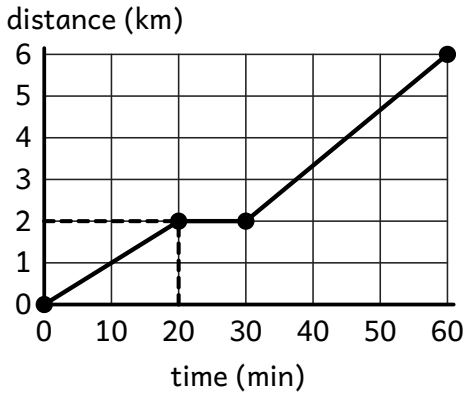
Draw the graph of Amina's walk



1 Mark a dot for each time and distance: (0, 0), (20, 2), (30, 2) and (60, 6).



2 Join the dots in order with straight lines.



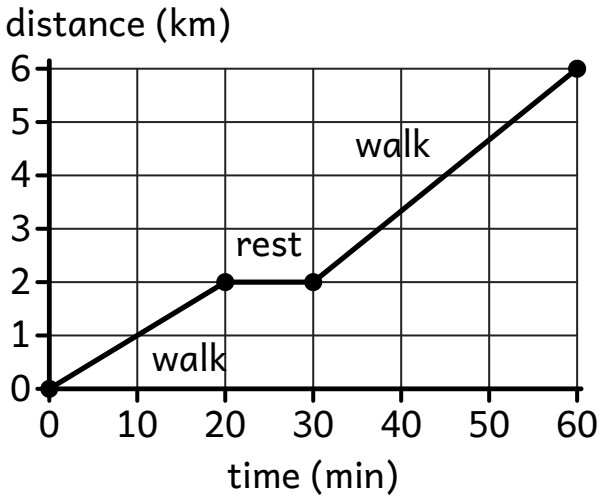
3 Read across from 20 minutes. She has gone 2 km.

WORKED EXAMPLE

In Amina's graph, how long does she rest?

1. A rest is a flat part of the graph. The flat part is from 20 minutes to 30 minutes.
2. Along it the distance stays 2 km. She does not move.
3. The rest lasts 30 − 20 = 10 minutes.

Answer: 10 minutes



The flat part is the rest. The last part is steeper, so she walks faster.

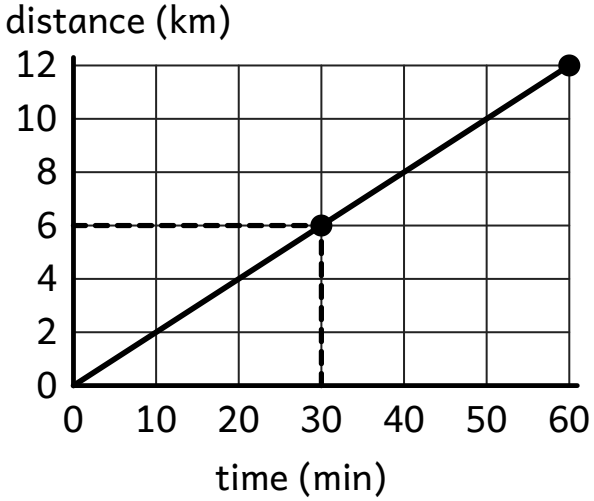
The steepness of a distance time graph is a speed. This is the gradient from chapter 6: the distance gone, divided by the time taken. A steeper line means a faster speed.

WORKED EXAMPLE

Kofi cycles at a steady speed. The graph shows that he goes 6 km in 30 minutes. What is his speed in km per hour?

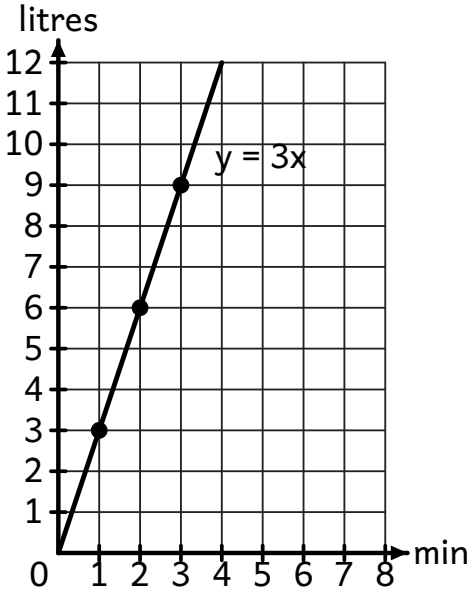
1. In 30 minutes he goes 6 km. Half an hour is 30 minutes.
2. In a whole hour he goes twice as far: 6 × 2 = 12 km.
3. His speed is 12 km per hour.

Answer: 12 km per hour



A straight line means a steady speed. In 30 minutes he goes 6 km.

Now a different kind of graph. A tap fills a bucket with 3 litres each minute. Here the bucket starts empty. After 1 minute there are 3 litres, after 2 minutes 6 litres. The points lie on a straight line through (0, 0).



The bucket starts empty, so the line starts at (0, 0). Litres ÷ minutes is 3 every time.

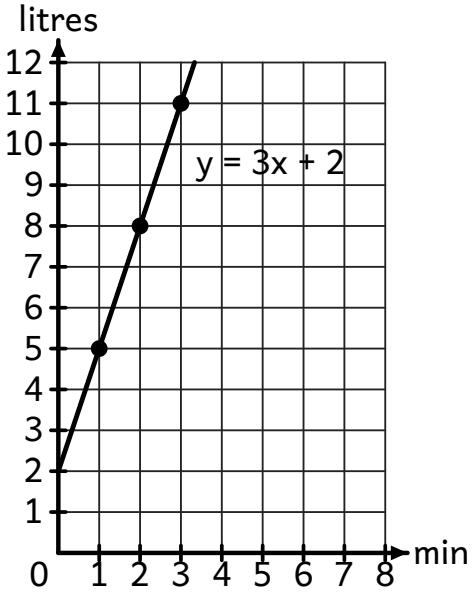
Now start the bucket with 2 litres in it. The line is still straight, but it starts at (0, 2). It misses (0, 0). Litres ÷ minutes is not always the same: 5 ÷ 1 = 5 but 8 ÷ 2 = 4.

WORKED EXAMPLE

A straight line goes through (1, 5) and (2, 8). The x number is minutes and the y number is litres. Is the water in direct proportion to the time?

1. Direct proportion needs a straight line through (0, 0).
2. For the first point, y ÷ x is 5 ÷ 1 = 5.
3. For the second point, y ÷ x is 8 ÷ 2 = 4.
4. The two answers are not the same, so the line cannot go through the origin. If it did, the point with x = 2 would be (2, 10), and 10 ÷ 2 = 5.
5. The water is not in direct proportion to the time.

Answer: No. The line does not pass through the origin.



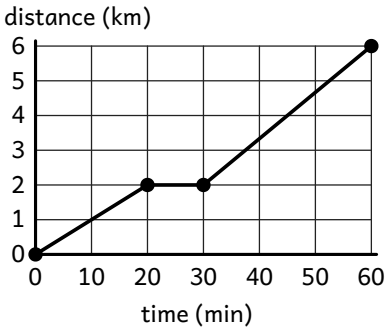
The rule is y = 3x + 2. The bucket starts with 2 litres, so the line starts at (0, 2). It is straight, but it is not direct proportion.

SEE IT THREE WAYS

With things

Walk along a path. Every 10 minutes, count how far you are from the start.

As a picture



In symbols

The pairs of time and distance are (0, 0), (20, 2), (30, 2) and (60, 6). The flat part, 2 km at 20 minutes and at 30 minutes, is a rest.

TRY IT

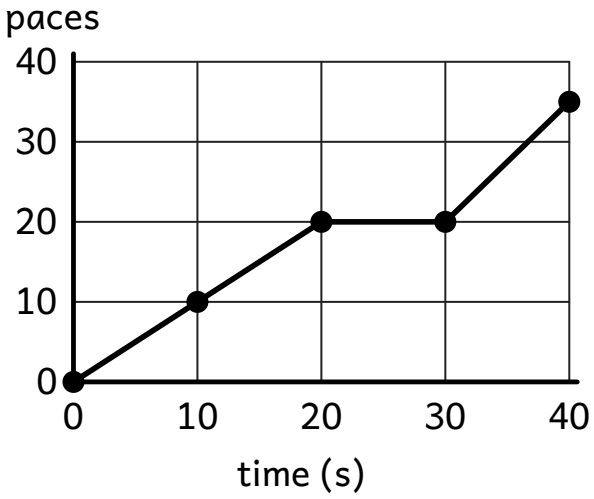
Graph your own walk

You need: a clock or a watch with seconds, a path or a yard, squared paper and a pencil.

1. Walk in a straight line at a steady pace. A friend counts your paces and calls the time every 10 seconds.
2. Stop for 10 seconds, then walk again. Your friend keeps calling the time.
3. Write down the pairs of time in seconds and distance in paces.
4. Plot the pairs and join them. Show time across and distance up.

What you will see: Your graph goes up while you walk and goes flat while you stand still. If you walk faster, the line is steeper.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A distance time graph is a picture of the path, so a line going up means a hill.~~

Why it feels right: The graph looks like a map, with a line that climbs and falls.

The test that breaks it: Amina walks on flat ground all the way. Her graph still goes up, because her distance grows as time goes by. It goes flat only while she rests.

What is true: The graph shows distance against time, not the shape of the ground. Up means she is further from the start. Flat means no movement. Steeper means faster.

KEY WORDS

distance time graph
a graph of how far something is from the start as time passes. Time goes across and distance goes up.

direct proportion
two amounts where y ÷ x is always the same. When one doubles, so does the other. Their graph is a straight line through (0, 0).

BACK TO YOUR GUESS

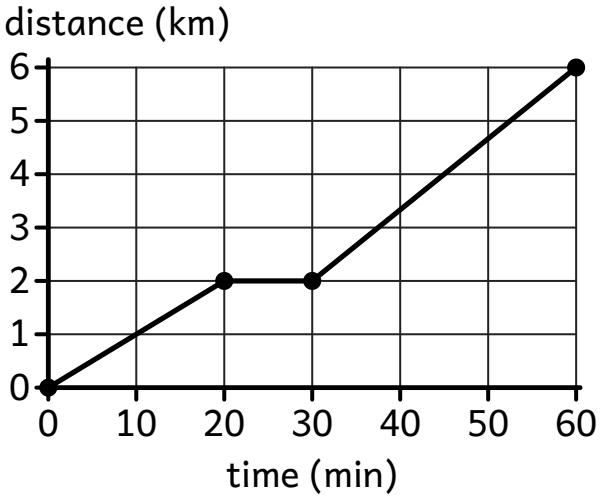
The answer is B: A flat part of a distance time graph means the person has stopped.

A distance time graph shows how far someone is from the start. A flat part means the distance does not change while time goes on. So the person is not moving. A steeper part means faster.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What does the flat part of Amina's graph mean?



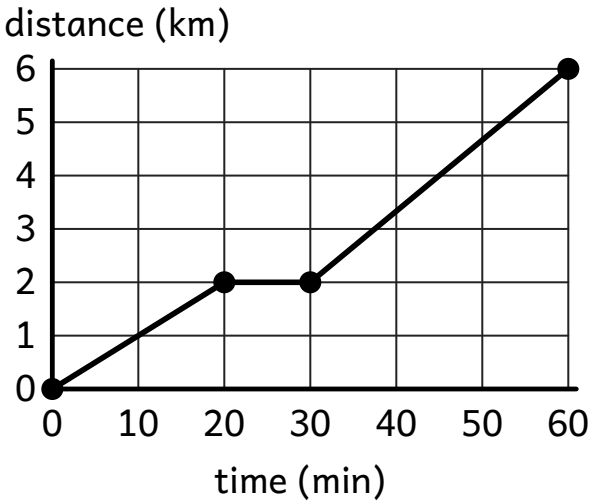
A She is walking faster.

B She is resting. She has stopped.

C She is walking back to the start.

Answer at the back of the book.

2. How far has Amina gone after 30 minutes?



A 4 km

B 30 km

C 2 km

D 6 km

Answer at the back of the book.

3. Which part of Amina's walk is the steepest?

   A The last 30 minutes

   B The first 20 minutes

   C The rest, from 20 to 30 minutes

   Answer at the back of the book.

4. A straight line goes from the origin to (60, 12), where x is minutes and y is km. What is the speed in km per hour?

   A 0.2 km per hour

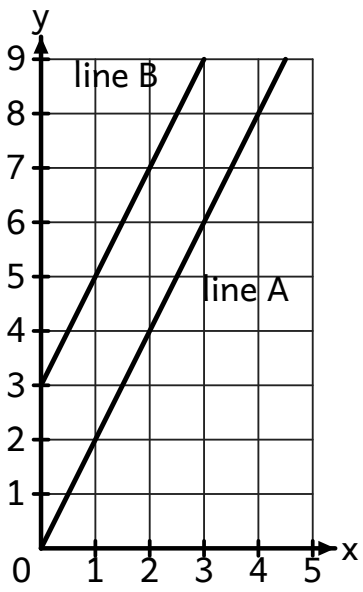
   B 5 km per hour

   C 72 km per hour

   D 12 km per hour

   Answer at the back of the book.

5. Which of these lines shows direct proportion?



   A Line A

   B Line B

   C Both lines

   Answer at the back of the book.

6. A cyclist goes 15 km in 3 hours at a steady speed. What is the speed in km per hour?

   Answer at the back of the book.

7. On a distance time graph the flat part runs from 15 minutes to 40 minutes. How many minutes is the rest?

   Answer at the back of the book.

8. **From an earlier chapter**

   What is the gradient of the line $y = 7x - 3$?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

On a distance time graph, up means further away, flat means stopped, and steeper means faster. A straight line through (0, 0) is direct proportion. A line that misses (0, 0) is not.

Draw: Draw time in minutes across and distance in km up. Plot (0, 0), (20, 2), (30, 2) and (60, 6). Join them and write "rest" on the flat part.

Key words, A to Z

Every key word in this book, what it means, and the chapter that teaches it.

axis
a number line on a grid. The x axis goes across and the y axis goes up. M3.9.1

coordinates
two numbers that name a place on a grid. Across comes first, then up. M3.9.1

direct proportion
two amounts where y ÷ x is always the same. When one doubles, so does the other. Their graph is a straight line through (0, 0). M3.9.8

distance time graph
a graph of how far something is from the start as time passes. Time goes across and distance goes up. M3.9.8

gradient
how steep a line is. It is the rise divided by the run. M3.9.6

horizontal
flat, going straight across. The line y = −2 is horizontal. M3.9.5

image
the shape after it has been moved. M3.9.3

midpoint
the point exactly halfway along a line. M3.9.3

origin
the place where the two axes cross. Its coordinates are (0, 0). M3.9.1

parallel
lines with the same gradient. They never meet. M3.9.7

plot
to mark a point on a grid. M3.9.1

quarter
one of the four parts the two axes cut the grid into. M3.9.2

reflection
a flip over a mirror line. The image is the mirror image. M3.9.3

rise
how far up you go between two points. It is negative if you go down. M3.9.6

rule
a sentence with x and y, such as y = 2x + 1, that gives y for each x. M3.9.4

run
how far across you go between two points. M3.9.6

table of values
a list of x numbers with the y number that the rule gives for each. M3.9.4

translation
a slide. Every point moves the same distance in the same direction. M3.9.3

vertical
upright, going straight up and down. The line x = 3 is vertical. M3.9.5

x coordinate
the first number of a point. It tells how far across, left or right. M3.9.2

y coordinate
the second number of a point. It tells how far up or down. M3.9.2

y intercept
the point where a line crosses the y axis. In y = mx + c it is (0, c). M3.9.7

Answers

M3.9.1. Coordinates

1. **Dot B**

   The point (4, 2) is 4 across and 2 up. Dot B is the one there.

   - **If you chose A:** Dot A is 2 across and 4 up. You went up first. The first number is across. Go to M3.9.1.
   - **If you chose B:** Dot C is 4 across but also 4 up. The second number of (4, 2) is 2. Go to M3.9.1.
   - **If you chose D:** Dot D is 2 across and 2 up. The first number of (4, 2) is 4. Go to M3.9.1.

2. **(5, 3)**

   P is 5 across and 3 up. So its coordinates are (5, 3).

   - **If you chose A:** You gave the up number first. Write across first: the line down meets the x axis at 5. Go to M3.9.1.
   - **If you chose B:** The line across from P meets the y axis at 3, not 5. Go to M3.9.1.
   - **If you chose C:** The line down from P meets the x axis at 5, not 3. Go to M3.9.1.

3. **Start at the origin. Go 6 across, then 1 up.**

   Coordinates count from the origin. The first number, 6, is across. The second number, 1, is up.

   - **If you chose A:** That plots (1, 6). The first number is across. Go to M3.9.1.
   - **If you chose C:** Coordinates always count from the origin. Starting anywhere else gives another place. Go to M3.9.1.

4. **On the y axis, 4 up from the origin.**

   It is 0 across, so it stays on the y axis. It is 4 up.

   - **If you chose A:** The across number is 0, so it does not move right. It is on the y axis. Go to M3.9.1.
   - **If you chose B:** The origin is (0, 0). This point goes 4 up. Go to M3.9.1.

5. **(0, 0)**

   The origin is where the axes cross. It is 0 across and 0 up.

   - **If you chose B:** The axes start counting at 0, not at 1. Go to M3.9.1.
   - **If you chose C:** That is 1 up from the origin. The origin is 0 across and 0 up. Go to M3.9.1.

6. **(6, 2)**

   The first number is across, 6. The second number is up, 2. So she is at (6, 2).

7. **6**

   The second number is the number up. The point (2, 6) is 6 up.

M3.9.2. All four quarters of the grid

1. **Point C**

   The bottom left quarter has both numbers negative. C is (−3, −2).

   - **If you chose A:** A is 3 right and 2 up. That is the top right quarter. Go to M3.9.2.
   - **If you chose B:** B is left, which fits the bottom left. But it is 2 up. The bottom left needs a down number. Go to M3.9.2.
   - **If you chose D:** D is 2 down, which fits. But it is 3 right. The bottom left needs a left number. Go to M3.9.2.

2. **4 left and 2 up**

   The first number, −4, is 4 left. The second number, 2, is 2 up.

   - **If you chose A:** That is the point (4, −2). The signs are the other way round. Go to M3.9.2.
   - **If you chose C:** The second number, 2, has no minus sign. So it goes up. Go to M3.9.2.
   - **If you chose D:** You swapped the numbers. The first number, −4, is across. Go to M3.9.1.

3. **(−3, −4)**

   The dashed line up meets the x axis at −3. The dashed line across meets the y axis at −4. So M is (−3, −4).

   - **If you chose A:** M is left of the y axis and below the x axis. Both numbers are negative. Go to M3.9.2.
   - **If you chose B:** You swapped the numbers. The line up from M meets the x axis at −3. Across comes first. Go to M3.9.1.
   - **If you chose C:** M is below the x axis, so the second number is negative. Go to M3.9.2.

4. **(0, −3)**

   A point on the y axis is 0 across. It has no left or right move. The point (0, −3) is 3 down from the origin.

   - **If you chose A:** This point has 0 up, so it sits on the x axis. Go to M3.9.2.
   - **If you chose B:** This point is 3 left and 3 down. It is in the bottom left quarter, not on an axis. Go to M3.9.2.

5. **(−3, 2)**

   D is above A, so its across number is −3. It is level with C, so its up number is 2.

   - **If you chose B:** You swapped the numbers. D is above A, so it has A's across number, −3. Go to M3.9.2.
   - **If you chose C:** You went 4 right of C. D is on the other side of the square, level with C. Go to M3.9.2.
   - **If you chose D:** You went down from A. D is 4 above A, not below it. Go to M3.9.2.

6. **(−2, 3)**

   The fourth corner is above the first, so it has across number −2. It is level with the third, so it has up number 3.

7. **4**

   The first number, −4, says 4 left. The point is 4 units left of the y axis.

8. **(7, 2)**

   Across comes first, so the first number is 7. The second number is 2.

M3.9.3. Shapes on a grid

1. **(5, 4)**

   (2 + 8) ÷ 2 = 5 and (6 + 2) ÷ 2 = 4. The midpoint is (5, 4).

   - **If you chose A:** You added the numbers but did not halve them. The midpoint is halfway. Go to M3.9.3.
   - **If you chose C:** You took away instead of adding. The middle comes from adding the two numbers and halving. Go to M3.9.3.
   - **If you chose D:** You found half the gap, 3 across and 2 up. You did not add it to the start point. Add the two numbers, then halve. Go to M3.9.3.

2. **(1, −1)**

   3 − 2 = 1 and 4 − 5 = −1. The point goes to (1, −1).

   - **If you chose A:** You moved it 2 right and 5 up. Left means take away from the across number and down means take away from the up number. Go to M3.9.3.
   - **If you chose B:** That is only the move. Add the move to the point: 3 − 2 and 4 − 5. Go to M3.9.3.
   - **If you chose C:** The first number is right but down means take away. 4 − 5 is −1. Go to M3.9.2.

3. **(−3, −5)**

   The x axis is the mirror. The across number stays −3. The up number 5 changes sign to −5.

   - **If you chose A:** That is a reflection in the y axis. The x axis is the mirror here, so the up number changes sign. Go to M3.9.3.
   - **If you chose B:** You changed both signs. A mirror in the x axis changes only the up number. Go to M3.9.3.

4. **(−3, 1)**

   In the y axis the up number stays 1. The across number 3 changes sign to −3.

   - **If you chose B:** That would be a reflection in the x axis. Here the y axis is the mirror. Go to M3.9.3.
   - **If you chose C:** You changed both signs. Only the across number changes sign for the y axis. Go to M3.9.3.

5. **Every point of the shape moves the same distance in the same direction.**

   A translation slides the whole shape. The image has the same size and the same way up.

   - **If you chose B:** That is a reflection. A translation only slides the shape. Go to M3.9.3.
   - **If you chose C:** In a translation every corner moves by the same amount, so the shape does not change. Go to M3.9.3.

6. **(4, 6)**

   (2 + 6) ÷ 2 = 4 and (3 + 9) ÷ 2 = 6. The midpoint is (4, 6).

7. **(6, −2)**

   2 + 4 = 6 and 3 − 5 = −2. The point goes to (6, −2).

8. **Bottom left**

   Both numbers are negative. The point is left of the y axis and below the x axis.

   - **If you chose A:** The point has a negative across number, so it is left of the y axis. Go to M3.9.2.
   - **If you chose B:** The up number is −1, so the point is below the x axis. Go to M3.9.2.
   - **If you chose D:** The across number is −6, so the point is left, not right. Go to M3.9.2.

M3.9.4. From a rule to a line

1. **7**

   2 × 3 = 6. Then 6 + 1 = 7.

   - **If you chose A:** You doubled 3 but forgot to add 1. Go to M3.9.4.
   - **If you chose B:** You added 3 + 2. The 2 in 2x means 2 times x. Go to M3.8.2.
   - **If you chose D:** You worked out 2 × 3 = 6 and then added 3. The rule adds 1. Go to M3.9.4.

2. **−4**

   Put x = −1 into y = x − 3. Then y = −1 − 3 = −4.

   - **If you chose A:** You worked out 1 − 3. But x is −1, so the sum is −1 − 3. Go to M3.1.2.
   - **If you chose C:** You added 3 instead of taking it away. The rule says y = x − 3. Go to M3.9.4.
   - **If you chose D:** You dropped the minus signs. Both −1 and the −3 matter. Go to M3.1.1.

3. **(2, 3)**

   Put x = 2 into y = 2x − 1. Then y = 2 × 2 − 1 = 3, so (2, 3) is on the line.

   - **If you chose A:** Put x = 2 into the rule. You get y = 3, not 5. Go to M3.9.4.
   - **If you chose B:** Put x = 1 into the rule. You get y = 1, not 2. Go to M3.9.4.
   - **If you chose C:** Put x = 3 into the rule. You get y = 5, not 4. Go to M3.9.4.

4. **(3, 8)**

   Put x = 3 into the rule: 2 × 3 + 1 = 7, not 8. The point should be (3, 7).

   - **If you chose A:** Check it: 2 × 2 + 1 = 5. This point is right. Go to M3.9.4.
   - **If you chose C:** Check it: 2 × 0 + 1 = 1. This point is right. Go to M3.9.4.
   - **If you chose D:** Check it: 2 × 1 + 1 = 3. This point is right. Go to M3.9.4.

5. **(0, −1)**

   The line crosses the y axis where x = 0. Then y = 3 × 0 − 1 = −1.

   - **If you chose B:** On the y axis the across number is 0, so x = 0. Go to M3.9.4.
   - **If you chose C:** The 3 is the number in front of x. That is the gradient, not where the line crosses. Go to M3.9.4.
   - **If you chose D:** On the y axis the across number is 0, so x = 0. Go to M3.9.4.

6. **10**

   4 × 3 = 12. Then 12 − 2 = 10.

7. **3**

   Put x = −2 into y = x + 5. Then y = −2 + 5 = 3.

8. **(3, 2)**

   (0 + 6) ÷ 2 = 3 and (0 + 4) ÷ 2 = 2. The midpoint is (3, 2).

M3.9.5. Lines like x = 3 and y = −2

1. **Line A**

   Every point on x = 3 has x = 3. So the line is upright through 3 on the x axis. That is line A.

   - **If you chose A:** Line B is flat. It is the line y = −2, not x = 3. Go to M3.9.5.
   - **If you chose C:** Line C slants. It is the line y = x. In x = 3 every point has x = 3. Go to M3.9.5.

2. **A flat line, 2 below the x axis.**

   Every point has y = −2. They all sit 2 below the x axis, side by side. So the line is flat.

   - **If you chose A:** An upright line comes from x = −2. The rule y = −2 fixes how far up or down. Go to M3.9.5.
   - **If you chose B:** It is flat, which is right. But −2 is negative, so it is below the x axis. Go to M3.9.2.

3. **(4, −1)**

   A point on x = 4 has an across number of 4. The up number can be anything, so (4, −1) is on it.

   - **If you chose A:** The 4 here is the up number. On x = 4 the across number must be 4. Go to M3.9.5.
   - **If you chose B:** The sign matters. The across number is −4, not 4. Go to M3.9.5.
   - **If you chose D:** The sign matters. The across number is −4, not 4. Go to M3.9.5.

4. **(2, 5)**

   The crossing point is on both lines. It has x = 2 from the first line and y = 5 from the second.

   - **If you chose A:** You swapped the numbers. The line x = 2 gives the across number. Go to M3.9.1.
   - **If you chose C:** The line y = 5 fixes the up number at 5, not 2. Go to M3.9.5.
   - **If you chose D:** The line x = 2 fixes the across number at 2, not 5. Go to M3.9.5.

5. **(2, 3)**

   At (2, 3), the first rule gives 2 + 1 = 3 and the second gives −2 + 5 = 3. Both fit.

   - **If you chose B:** You swapped the numbers. Across comes first. Go to M3.9.5.
   - **If you chose C:** This point is on one line only. Put it into both rules to check. Go to M3.9.5.
   - **If you chose D:** This point is on one line only. Put it into both rules to check. Go to M3.9.5.

6. **(3, 5)**

   On x = 3 every point has x = 3. Put x = 3 into y = x + 2. Then y = 5. The lines cross at (3, 5).

7. **(3, 4)**

   On y = 4 every point has y = 4. Put y = 4 into y = x + 1, so 4 = x + 1 and x = 3. The lines cross at (3, 4).

8. **−5**

   3 × (−2) = −6. Then −6 + 1 = −5.

M3.9.6. Steepness: the gradient

1. **2**

   The run is 4 − 1 = 3 and the rise is 8 − 2 = 6. The gradient is 6 ÷ 3 = 2.

   - **If you chose A:** You divided the run by the rise: 3 ÷ 6. The gradient is rise ÷ run. Go to M3.9.6.
   - **If you chose B:** You added 3 and 6. The gradient is the rise divided by the run. Go to M3.9.6.
   - **If you chose C:** That is the rise only. Divide it by the run, 3. Go to M3.9.6.

2. **−2**

   The run is 3 − 0 = 3. The rise is 0 − 6 = −6, because the line goes down. The gradient is −6 ÷ 3 = −2.

   - **If you chose B:** The size is right, but the line goes down to the right. A line going down has a negative gradient. Go to M3.9.6.
   - **If you chose C:** You divided the run, 3, by the rise, 6. The gradient is rise ÷ run: −6 ÷ 3. Go to M3.9.6.
   - **If you chose D:** That is the run. The rise is −6, and the gradient is rise ÷ run. Go to M3.9.6.

3. **y = 5x − 1**

   The number in front of x is the gradient. The biggest gradient is 5, so y = 5x − 1 is the steepest.

   - **If you chose A:** The number in front of x is 1. A bigger number makes a steeper line. Go to M3.9.6.
   - **If you chose B:** The number in front of x is 3. A bigger number makes a steeper line. Go to M3.9.6.
   - **If you chose D:** The number in front of x is 2. A bigger number makes a steeper line. Go to M3.9.6.

4. **It is negative.**

   Going to the right, the rise is negative because the line goes down. So the gradient is negative.

   - **If you chose B:** A positive gradient goes up to the right. This line goes down. Go to M3.9.6.
   - **If you chose C:** A gradient of zero is a flat line. This line goes down. Go to M3.9.6.

5. **−2**

   The number in front of x is the gradient. In y = −2x + 3 it is −2.

   - **If you chose B:** That is where the line crosses the y axis. The gradient is the number in front of x. Go to M3.9.6.
   - **If you chose C:** You dropped the minus sign. The number in front of x is −2. Go to M3.9.6.
   - **If you chose D:** The number in front of x is −2. The 3 is added on its own. Go to M3.9.6.

6. **0**

   On a flat line the rise is 0 for any run. The gradient is 0 ÷ run = 0.

   - **If you chose A:** The 4 tells how high the line is. The gradient is the rise divided by the run, and a flat line has no rise. Go to M3.9.6.
   - **If you chose C:** Only an upright line has no gradient. A flat line has a run, and its rise is 0. Go to M3.9.6.

7. **3**

   The run is 4 − 1 = 3. The rise is 11 − 2 = 9. The gradient is 9 ÷ 3 = 3.

8. **3**

   The gradient is the rise divided by the run. 12 ÷ 4 = 3.

9. **(2, 6)**

   The line x = 2 gives the across number, 2. The line y = 6 gives the up number, 6.

M3.9.7. The equation y = mx + c

1. **3**

   In y = mx + c the number in front of x is m, the gradient. Here it is 3.

   - **If you chose A:** That is where the line crosses the y axis. The gradient is the number in front of x. Go to M3.9.7.
   - **If you chose B:** You may have dropped the minus sign and picked the lone number. The gradient is in front of x. Go to M3.9.7.
   - **If you chose D:** The gradient is not always 1. Look at the number in front of x. Go to M3.9.6.

2. **(0, −2)**

   On the y axis x = 0. The number on its own is −2, so the line crosses at (0, −2).

   - **If you chose B:** The 3 is the gradient. The lone number tells where it crosses. Go to M3.9.7.
   - **If you chose C:** You swapped the numbers. On the y axis the across number is 0. Go to M3.9.1.
   - **If you chose D:** You dropped the minus sign. The lone number is −2. Go to M3.9.2.

3. **y = 2x − 3**

   The line crosses the y axis at (0, −3), so c = −3. The rise is 4 and the run is 2, so m = 4 ÷ 2 = 2.

   - **If you chose A:** The line crosses the y axis below the origin, at −3, not above it. Go to M3.9.7.
   - **If you chose B:** You swapped m and c. The number in front of x is the gradient. The lone number is where the line crosses the y axis. Go to M3.9.7.
   - **If you chose C:** You used the rise, 4, as the gradient. The gradient is the rise divided by the run: 4 ÷ 2. Go to M3.9.7.

4. **y = 4x − 5**

   Parallel lines have the same gradient. The gradient of y = 4x + 1 is 4. Only y = 4x − 5 also has gradient 4.

   - **If you chose A:** You swapped m and c. Parallel lines have the same gradient, the number in front of x. This line has a different one. Go to M3.9.7.
   - **If you chose C:** Matching the lone number is not enough. Parallel lines have the same number in front of x. Go to M3.9.7.

5. **It goes down to the right and crosses the y axis at 4.**

   The gradient is −1, which is negative, so the line goes down. The lone number is 4, so it crosses at (0, 4).

   - **If you chose A:** The number in front of x is −1. A negative gradient goes down to the right. Go to M3.9.6.
   - **If you chose B:** The −1 is the gradient. The lone number, 4, tells where it crosses the y axis. Go to M3.9.7.

6. **3**

   The run is 2 − 0 = 2. The rise is 10 − 4 = 6. The gradient is 6 ÷ 2 = 3.

7. **−6**

   On the y axis x = 0. Put x = 0 into y = 4x − 6. Then y = −6.

8. **3**

   The run is 5 − 2 = 3. The rise is 10 − 1 = 9. The gradient is 9 ÷ 3 = 3.

M3.9.8. Graphs from real life

1. **She is resting. She has stopped.**

   In the flat part the distance stays the same while the time goes on. So she is not moving.

   - **If you chose A:** Walking faster makes the line steeper, not flat. Go to M3.9.8.
   - **If you chose C:** Walking back would make the line go down. In the flat part the distance does not change. Go to M3.9.8.

2. **2 km**

   Read up from 30 minutes to the line, then across to the distance axis. The line is at 2 km.

   - **If you chose A:** That is the distance at 45 minutes. At 30 minutes read up from 30 to the line, then across. Go to M3.9.8.
   - **If you chose B:** The 30 is the time, in minutes. The distance is on the axis going up. Go to M3.9.8.
   - **If you chose D:** That is the distance at 60 minutes, at the end of the walk. Go to M3.9.8.

3. **The last 30 minutes**

   Speed is the distance divided by the time. At first she goes 2 km in 20 minutes, which is 6 km per hour. Later she goes 4 km in 30 minutes, which is 8 km per hour. So the last part is steepest.

   - **If you chose B:** In the first 20 minutes she goes 2 km. In the last 30 minutes she goes 4 km, which is faster. Go to M3.9.8.
   - **If you chose C:** The rest is flat. It is the least steep part of the graph. Go to M3.9.8.

4. **12 km per hour**

   60 minutes is 1 hour. In 1 hour the line shows 12 km. So the speed is 12 km per hour.

   - **If you chose A:** 12 ÷ 60 = 0.2 is the km in one minute. Multiply by 60 to get the km in one hour. Go to M3.9.8.
   - **If you chose B:** You divided 60 by 12. The speed is the distance divided by the time. Go to M3.4.6.
   - **If you chose C:** You added 60 and 12. The speed is distance ÷ time, using 60 minutes as one hour. Go to M3.4.6.

5. **Line A**

   Line A is straight and goes through (0, 0). Line B is straight too, but it misses the origin.

   - **If you chose B:** Line B is straight, but it starts at 3 on the y axis. For direct proportion the line must go through (0, 0). Go to M3.9.8.
   - **If you chose C:** A straight line is not enough. It must also go through the origin. Go to M3.4.5.

6. **5**

   Speed is the distance divided by the time. 15 ÷ 3 = 5 km per hour.

7. **25**

   The rest lasts from 15 to 40 minutes. 40 − 15 = 25 minutes.

8. **7**

   In y = mx + c the number in front of x is the gradient. Here it is 7.

About this book

For learners who can find the value of 2x + 3 when x = 4 and who know negative numbers. In many schools this fits children of about 11 to 13, and older learners who never drew a graph can start here too. Each idea is drawn on an exact grid before it is written as a rule. Each chapter takes one or two short sessions. A learner can work alone: every exercise has its answer and the reason for it. Each chapter also has a short page for the adult, with three questions to ask.

Written and drawn by attnom. Edition 1.0, 2026-11-12.

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