Mathematics Level 5

Chapter 6 — Space

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Contents

Objects and their nets

connect objects to their nets and build objects from their nets using spatial and geometric reasoning — VC2M5SP01

Level 5 achievement standard (extract): *Students connect objects to their two-dimensional nets.*

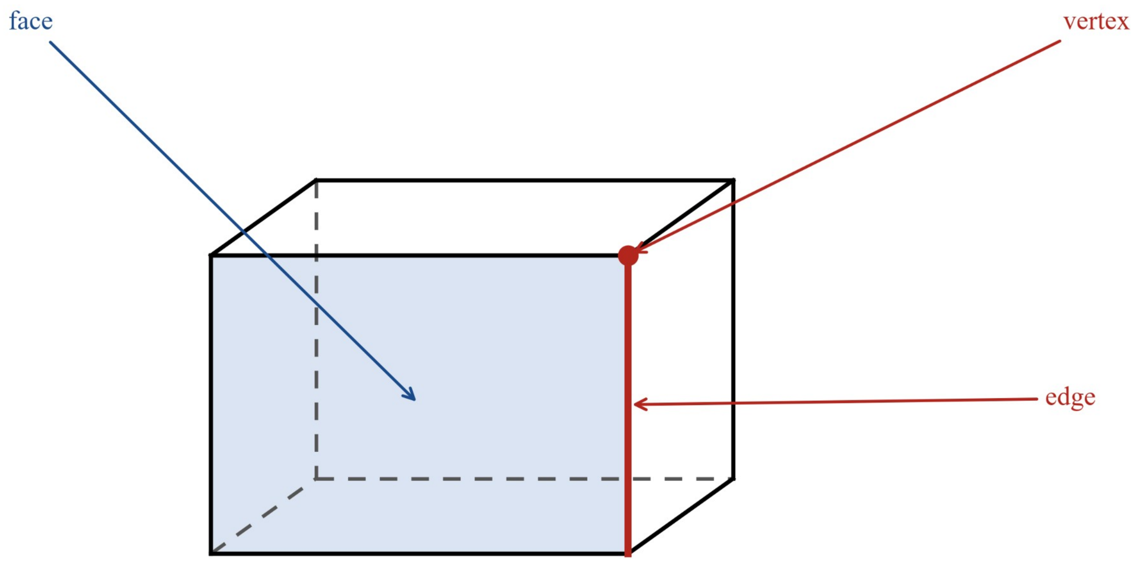
Look at any box in the room — a die, a tissue box, a cereal box. If you cut it along some of its edges and opened it out flat, you would get a flat shape called a **net**. In this section you go both ways: from an object to its net, and from a net back to the object it makes. You will also learn to predict whether a flat shape folds into a solid, before you ever pick up the scissors.

Theory

The parts of a solid

A **solid** is a 3-D shape: it has length, width and height. The flat surfaces of a solid are its **faces**. Where two faces meet there is a straight **edge**, and where edges meet there is a corner called a **vertex**. More than one vertex is written **vertexes**.

The parts of a solid



A solid has flat faces, straight edges and corners called vertexes.

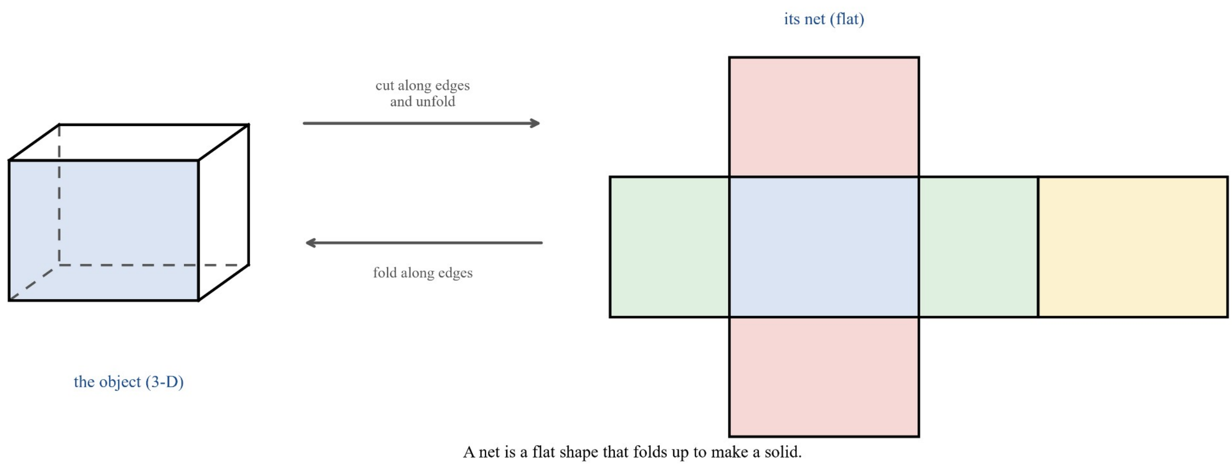
A cuboid with its front face shaded, one edge drawn thick in red and one corner marked with a dot, labelled face, edge and vertex.

In the picture, the shaded face and the red edge meet at the red vertex. Every solid in this section is built from just these three parts.

What is a net?

A **net** is a flat shape that folds up to make a solid. Each face of the solid appears once in the net, joined edge to edge. The joined edges are the **fold lines**: the net folds along them.

An object and its net

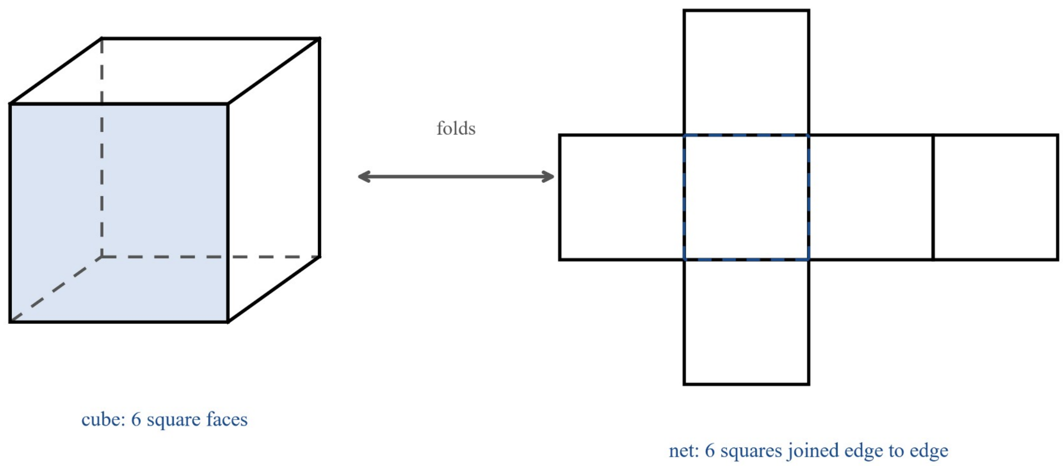


A cuboid on the left and its net on the right, a strip of four rectangles with one rectangle above and one below. An arrow from the cuboid to the net says cut along edges and unfold; an arrow back says fold along edges.

The picture shows both directions of the idea. Going one way, you cut the solid open and unfold it to get the net. Going the other way, you fold the net along its fold lines and the solid closes up. The matching faces are shaded the same colour in the solid and in the net.

One solid can have more than one net, because you can choose different edges to cut. A cube has 11 different nets. Here is a cube with one of them, the cross shape:

A cube and one of its nets



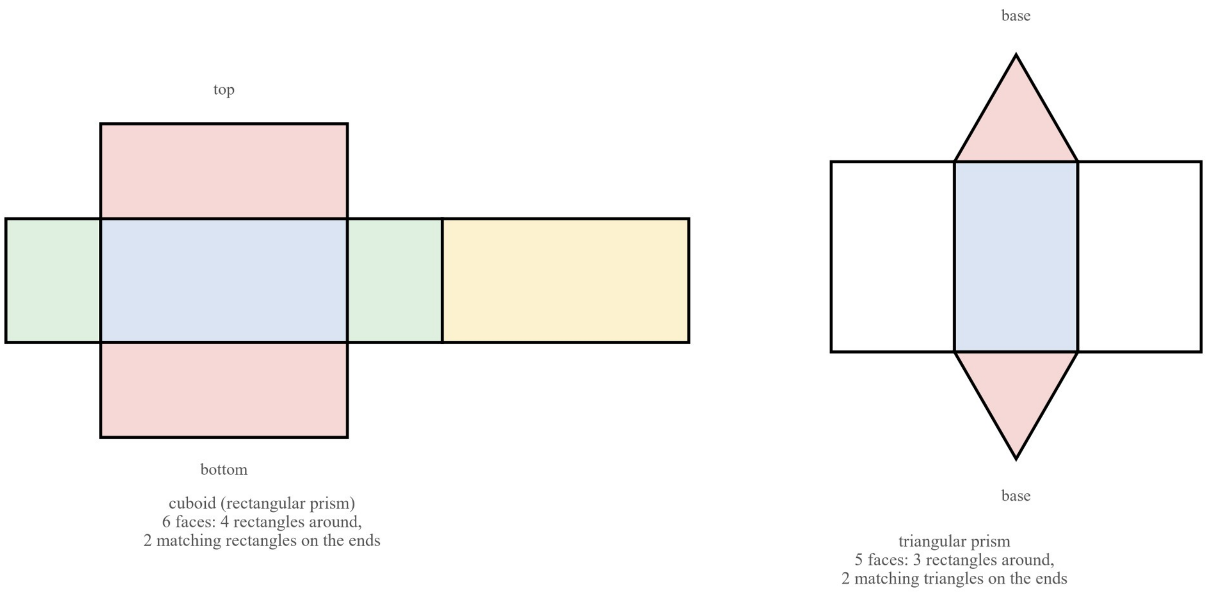
A cube on the left and one of its nets on the right: six squares joined in a cross, with the fold lines dashed.

Both the cube and the net have 6 square faces. The net spreads them out flat so you can see all 6 at once.

Nets of prisms

A **prism** is a solid with two identical ends, called its **bases**, joined by rectangles. A cube and a cuboid are prisms with rectangle bases; a **triangular prism** has triangle bases.

Nets of two prisms



Two nets side by side. Left: the net of a cuboid, a strip of four rectangles with the top rectangle above and the bottom rectangle below. Right: the net of a triangular prism, three rectangles in a row with a matching triangle above and below the middle rectangle.

Look at the two nets in the picture.

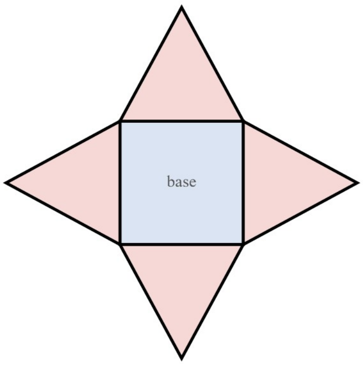
- The **cuboid** net has 6 rectangle faces: a strip of 4 rectangles that wraps around the sides, plus the top and the bottom. The top and the bottom are a matching pair, and they sit on opposite sides of the strip so they close the two open ends.
- The **triangular prism** net has 5 faces: a strip of 3 rectangles that wraps around the sides, plus two identical triangle bases, one on each side of the strip.

The rule to notice is this. In a prism net, the strip of rectangles wraps around the sides, and the two identical bases must close the two open ends — so they sit on opposite sides of the strip. If both bases were on the same side, they would fold on top of each other and one end would stay open.

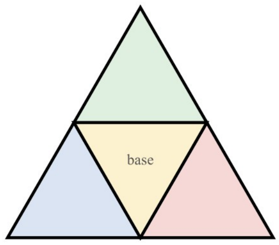
Nets of pyramids

A **pyramid** is a solid with one base and triangle faces that all meet at one point at the top. We name a pyramid by its base: a **square-based pyramid** has a square base, and a **triangular-based pyramid** has a triangle base.

Nets of two pyramids



square-based pyramid
5 faces: 1 square base,
4 triangles meeting at a point



triangular-based pyramid
4 faces: 1 triangle base,
3 triangles meeting at a point

Two nets side by side. Left: a square with a triangle on each of its four sides, the net of a square-based pyramid. Right: four identical triangles fitted together into one big triangle, the net of a triangular-based pyramid.

- The **square-based pyramid** net has 5 faces: the square base in the middle with 4 triangles hanging off its sides. Fold the triangles up and their points all meet at the one point at the top.
- The **triangular-based pyramid** net has 4 faces, all triangles: the base triangle in the middle with 3 triangles folded up around it.

Notice the difference between the two families. A prism net has two identical bases and a strip of rectangles; a pyramid net has one base and triangles that meet at a point.

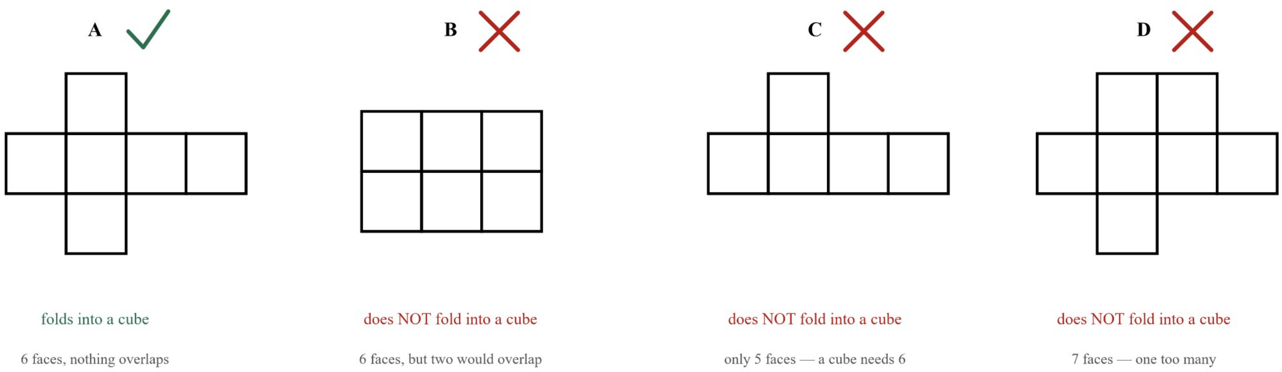
Predict, then test — will it fold?

You do not need scissors to rule out many flat shapes. Before folding, check three things:

1. **Count the faces.** The net must have exactly as many faces as the solid.
2. **Check the shapes and sizes.** The faces must match the faces of the solid — a cube net needs 6 squares of the same size, not 5 squares and a rectangle.
3. **Picture the fold in your head.** No two faces may land in the same place, and no face of the solid may be left open.

Then test your prediction by cutting out the shape and folding it. Predict first, test second — the test checks your reasoning.

Which of these fold into a cube? Predict, then test.



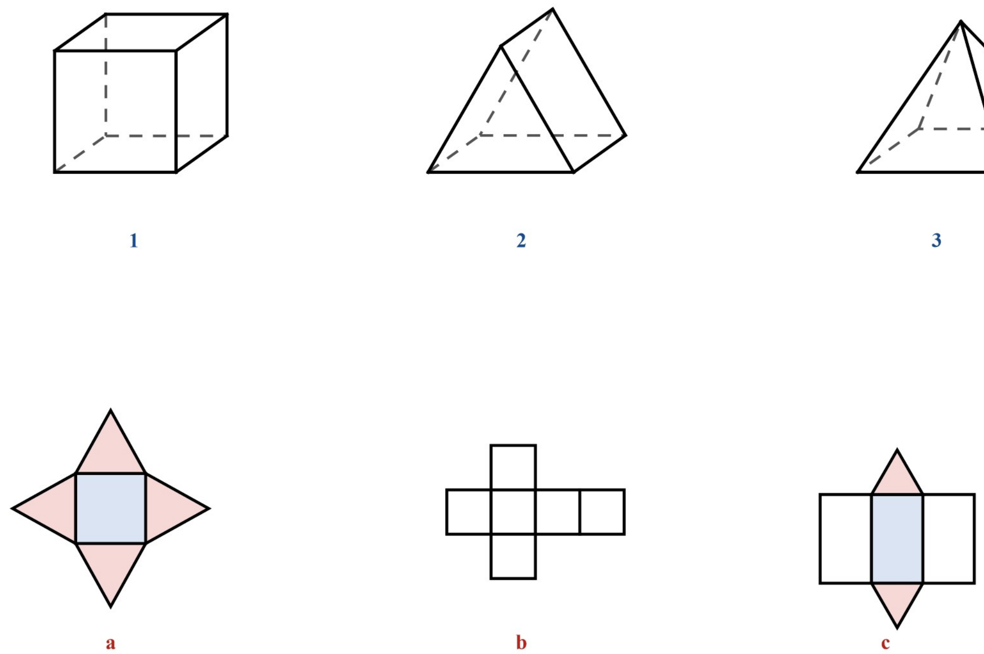
Count the faces first, then check that no two faces land in the same place.

Four flat shapes made of squares, labelled A, B, C and D. A is six squares in a cross and folds into a cube. B is six squares in a two-by-three block, C is only five squares and D is seven squares; B, C and D do not fold into a cube.

- **A** has 6 squares, the right number for a cube, and when it folds, every square lands on a different face of the cube. It works.
- **B** has 6 squares, so the count passes — but picture the fold. The bottom row of three becomes the bottom and the two side faces. The top row becomes the back, the top, and then a second square that also lands on the top. Two squares land in the same place, and the front face stays open. It fails.
- **C** has only 5 squares. A cube has 6 faces, so one face must stay open. It fails on the count, before any folding.
- **D** has 7 squares — one more than a cube has faces, so two squares must overlap. It fails on the count too.

Once you can predict and test, you can match any object to its net. Predict first, then check by folding:

Match each object to its net

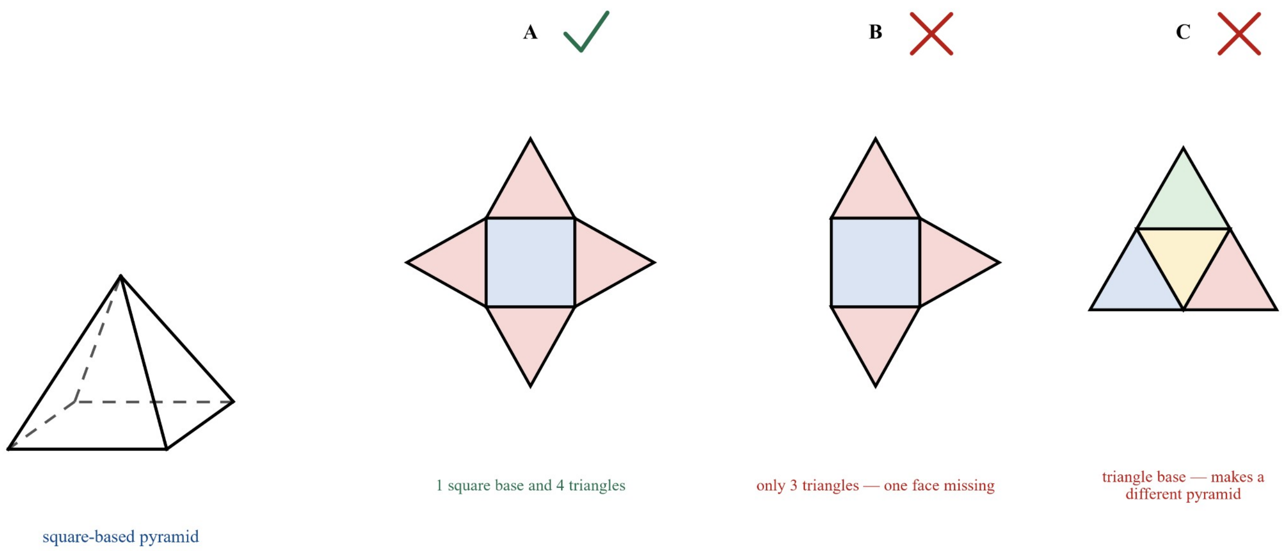


Draw a line from each object to the net that folds to make it.

Top row: a cube labelled 1, a triangular prism labelled 2 and a square-based pyramid labelled 3. Bottom row, in a different order: the pyramid net labelled a, the cube net labelled b and the prism net labelled c.

The same three checks work for pyramids.

Which net folds into this square-based pyramid?



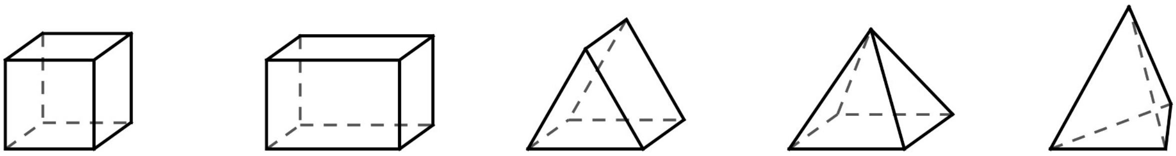
A square-based pyramid on the left and three nets labelled A, B and C. A is a square with four triangles and folds into the pyramid. B is a square with only three triangles. C is four triangles with a triangle base, which makes a different pyramid.

- **A** has the 5 faces of a square-based pyramid — 1 square base and 4 triangles, one on each side of the square. It folds into the pyramid.
- **B** has a square base but only 3 triangles. A square has 4 sides, so one side is left open. It fails on the count.
- **C** has 4 triangles and no square. It folds into a triangular-based pyramid — a solid, but not the one we asked for. It fails on the shapes.

Counting the parts

A net shows every face flat, so it is the easiest way to count the faces of a solid. The edges and vertexes can be counted on the solid itself. Here are the counts for the solids in this section:

Counting faces, edges and vertexes



Cube	Cuboid	Triangular prism	Square-based pyramid	Triangular-based pyramid
6 faces	6 faces	5 faces	5 faces	4 faces
12 edges	12 edges	9 edges	8 edges	6 edges
8 vertexes	8 vertexes	6 vertexes	5 vertexes	4 vertexes

Five solids in a row: cube, cuboid, triangular prism, square-based pyramid and triangular-based pyramid, each with its number of faces, edges and vertexes written beneath it.

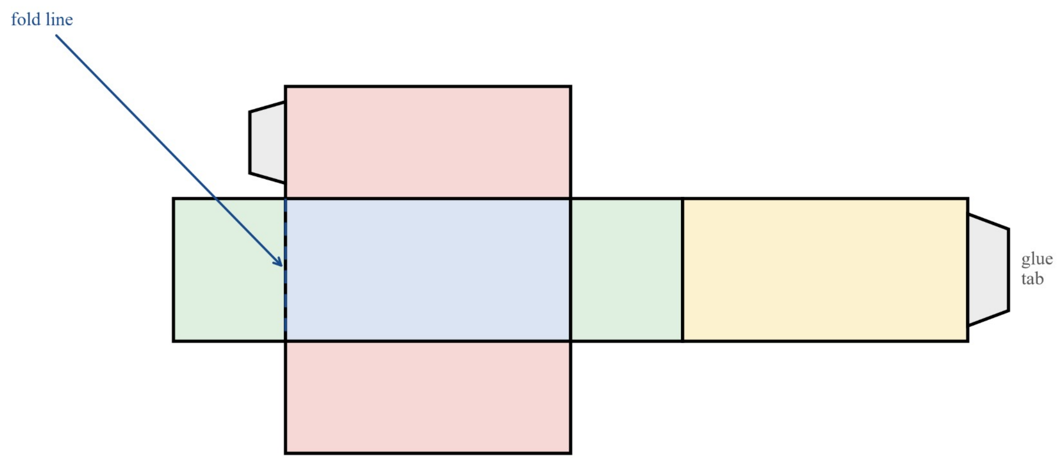
Check one row yourself on the pictures above. A cube: 6 square faces, 12 edges, 8 vertexes. A square-based pyramid: 5 faces, 8 edges, 5 vertexes — the 4 base edges plus the 4 slant edges meeting at the top point.

Designing a box

Nets are how real boxes are made. A cardboard box starts life as a flat net, cut from one sheet, with small extra **tabs** (glue flaps) on some edges. The tabs are glued to the matching edge to hold the box closed.

Designing a box: tabs join the faces

The tabs are glued to the matching edge to hold the box closed.



Think about how your box will open — a lid on top, or a flap on the side?

A cuboid net with two small grey glue tabs on its outer edges, and one fold line dashed and labelled.

A box designer chooses the net, and where the tabs go, so the box folds up and opens the right way — a lid on top, or a flap on the side. Every choice is checked with the same reasoning: the right number of faces, the right sizes, and no two faces landing in the same place.

Worked examples

Worked example 1 — step by step: from object to net (a cuboid)

Describe a net of a cuboid, like the left net in the prism figure.

Working	Comment
Count the faces: 6.	Top, bottom, front, back, left, right.
Match them in pairs: top = bottom, front = back, left = right.	A cuboid has 3 pairs of identical rectangles.
Put the 4 side faces in a strip: front, right, back, left.	The strip wraps around the sides of the cuboid.
Join the top to the top edge of the strip and the bottom to the bottom edge.	The two bases close the two open ends, so they sit on opposite sides of the strip.

∴ A net of a cuboid is a strip of 4 rectangles with one base above and one base below — 6 rectangles in all.

Worked example 2 — step by step: from net to object

A flat shape has 3 identical rectangles in a row, with an identical triangle above and below the middle rectangle. Name the solid it folds into.

Working	Comment
Count the faces: 3 rectangles + 2 triangles = 5.	The solid has 5 faces.
The two identical triangles close the two ends.	Two identical bases joined by rectangles means a prism.

Working	Comment
The base shape is a triangle.	A prism is named by its base.

∴ The net folds into a triangular prism.

Worked example 3 — step by step: predict, then test

Without folding, decide whether shape C in the cube figure folds into a cube, and say which check rules it out.

Working	Comment
A cube has 6 faces.	Count on any cube net or on the cube itself.
Shape C has 5 squares.	Count them on the figure.
5 is one short of 6.	Whatever way it folds, one face of the cube stays open.

∴ Shape C cannot fold into a cube. It fails check 1, the face count — so no folding is needed to rule it out. (Cut it out if you like: the fold leaves one face open, exactly as predicted.)

Worked example 4 — step by step: which object does net c make?

Use the matching figure. Decide which of the solids 1, 2 and 3 folds from net c.

Working	Comment
Count the faces of net c: 3 rectangles + 2 triangles = 5.	The solid has 5 faces.
Two identical triangles joined by a strip of rectangles.	Two identical bases closed by rectangles means a prism.
The base shape is a triangle.	A triangular prism.

∴ Net c folds into object 2, the triangular prism. The same method — count the faces, check the shapes, picture the fold — matches any net to its object.

Practice questions

Q1. Fill in the missing counts for each solid, using the counting figure.

a. Cube: 6 faces, ? edges, ? vertexes.
b. Cuboid: ? faces, 12 edges, ? vertexes.
c. Triangular prism: 5 faces, ? edges, 6 vertexes.
d. Square-based pyramid: ? faces, 8 edges, ? vertexes.
e. Triangular-based pyramid: 4 faces, 6 edges, ? vertexes.

Q2. True or false? If false, say why.

a. A net of a cube has exactly 6 squares.
b. All nets of a cube look the same.
c. The net of a square-based pyramid has 4 triangles.
d. A triangular prism has 6 faces.

Q3. Name the solid each net folds into.

a. 6 identical squares.
b. 2 identical triangles and 3 rectangles.
c. 1 square and 4 triangles.
d. 6 rectangles in 3 identical pairs.

Q4. Look at the cube predict figure. Shape B has 6 squares, the right number for a cube. Explain in your own words why it still fails.

Q5. Look at the pyramid predict figure. For nets B and C, say which of the three checks (count, shapes, fold) rules it out and why.

Q6. Match each object to its net in the matching figure.

Q7. The cross net folds into a cube. Predict: if the top square of the cross moves one square to the right, does the new shape still fold into a cube? Test your prediction by cutting one out.

Q8. A cereal box is a cuboid.

a. How many faces does its net have?
b. Look at the box-design figure. What are the small grey tabs for?

Q9. Priya says any flat shape made of 6 squares must fold into a cube. Use one shape from the cube predict figure to show she is wrong, and explain why.

Q10. A solid has 5 faces: 1 square and 4 triangles. The 4 triangles all meet at one point. Name the solid.

Q11. Describe a net of a triangular-based pyramid: how many faces, and what shape are they?

Q12. True or false? In a prism net, the two identical bases can both sit on the same side of the strip of rectangles and the net will still fold. Explain.

Answers

Q1. a. 12 edges, 8 vertexes. b. 6 faces, 8 vertexes. c. 9 edges. d. 5 faces, 5 vertexes. e. 4 vertexes.

Q2. a. True. b. False. c. True. d. False.

Q3. a. Cube. b. Triangular prism. c. Square-based pyramid. d. Cuboid (rectangular prism).

Q4. Any correct explanation; for example: the bottom row of three becomes the bottom and the two side faces, and the top row becomes the back, the top, and a second square on the top — so two squares overlap and the front face stays open.

Q5. B fails the count: a square-based pyramid needs 4 triangles and B has only 3, so one side of the base is left open. C fails the shapes check: it has no square base, so it makes a triangular-based pyramid, not a square-based one.

Q6. 1 → b, 2 → c, 3 → a.

Q7. Yes.

Q8. a. 6. b. They are glued to the matching edge to hold the box closed.

Q9. Shape B is 6 squares but does not fold into a cube (two squares overlap and one face stays open). So Priya is wrong.

Q10. A square-based pyramid.

Q11. 4 faces, all triangles: 1 base triangle with 3 triangles around it.

Q12. False.

Step-by-step solutions

Q1. Read the counts from the figure, or count on the solids: a. cube — 12 edges, 8 vertexes. b. cuboid — 6 faces, 8 vertexes. c. triangular prism — 9 edges. d. square-based pyramid — 5 faces, 5 vertexes. e. triangular-based pyramid — 4 vertexes.

Q2. a. True: a cube has 6 faces, all squares, and the net shows every face once. b. False: a cube has 11 different nets — the cross is only one of them. c. True: 4 triangles, one on each side of the square base. d. False: a triangular prism has 5 faces — 3 rectangles and 2 triangles.

Q3. a. 6 identical squares fold into a cube. b. Two identical triangle bases joined by rectangles: a triangular prism. c. One square base with 4 triangles meeting at a point: a square-based pyramid. d. Three pairs of identical rectangles: a cuboid.

Q4. Picture the fold. The bottom row of three becomes the bottom and the two side faces of the cube. The top row becomes the back, the top, and then a second square that also lands on the top. So two squares land on top of each other, and the front face is left open. The right count is not enough — the faces must also land in the right places.

Q5. B: the count. A square-based pyramid has 5 faces — 1 square and 4 triangles — but B has only 3 triangles, so when it folds, one side of the square base stays open. C: the shapes. C has 4 triangles and no square, so it folds into a triangular-based pyramid, which is a different solid from the one asked for.

Q6. 1 is the cube → b (6 squares). 2 is the triangular prism → c (3 rectangles and 2 triangles). 3 is the square-based pyramid → a (1 square and 4 triangles).

Q7. Predict first: the cross is a strip of 4 squares with one square above and one below. Moving the top square one place to the right still leaves one square above the strip and one below, on opposite sides, so the strip still wraps around and the two loose squares still close the two open ends. Test: cut it out and fold — it folds into a cube. ∴ Yes, the new shape still folds into a cube. (It is one of the 11 cube nets.)

Q8. a. A cuboid has 6 faces, so the net has 6 rectangles. b. The tabs are extra flaps glued to the matching edge to hold the box closed — the box would not stay shut without them.

Q9. Shape B from the figure is made of 6 squares, so it passes the count. But when it folds, the bottom row becomes the bottom and the two side faces while the top row becomes the back, the top, and a second square on the top: two squares overlap and the front face stays open. So 6 squares is not enough by itself, and Priya's rule is wrong.

Q10. One square base with 4 triangle faces meeting at one point is exactly a square-based pyramid. (The count matches the figure: 5 faces, 8 edges, 5 vertexes.)

Q11. A triangular-based pyramid has 4 faces, all triangles, so its net is 4 triangles: the base triangle with 3 triangles joined to its sides, as in the right-hand net of the pyramid figure. Fold the 3 outer triangles up and their points meet at the top point.

Q12. False. The strip of rectangles wraps around the sides and leaves two open ends. The two identical bases close those ends, one each, so they must sit on opposite sides of the strip. If both were on the same side, they would fold on top of each other and the other end would stay open.

Grid coordinate systems: describing position and movement

Chapter 6 · Subtopic 6B · Level 5

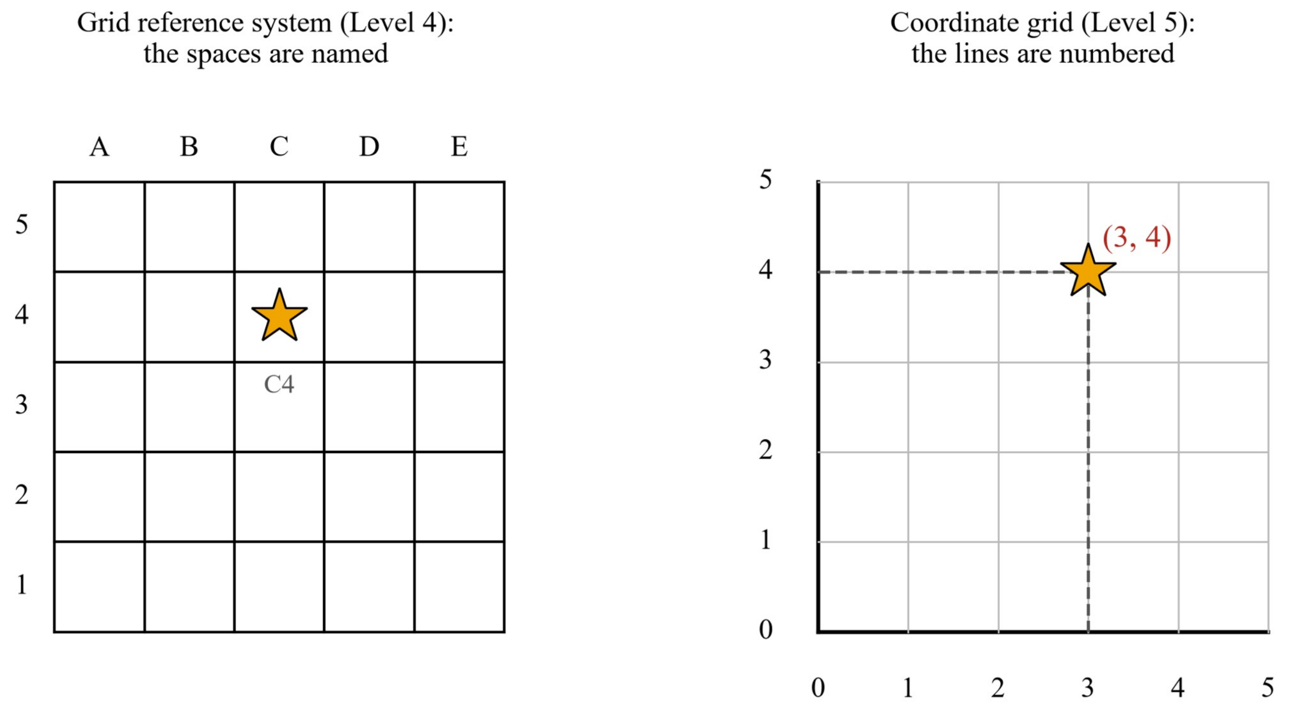
> *construct a grid coordinate system that uses coordinates to locate positions within a space; use coordinates and directional language to describe position and movement* — VC2M5SP02
>
> **From the Level 5 achievement standard:** *Students use grid coordinates to locate and move positions.*

At Level 4 you made and read grid **reference** systems: grids where each square carries a name like B3 or C4 (`VC2M4SP03`). This section builds the next kind of grid — a **coordinate grid** — where the numbers live on the lines instead of the squares. You will build a coordinate grid, use coordinates to name exact positions, and use direction words to describe position and movement. In 6C you will use those movement skills to slide, flip and turn shapes.

Theory

Two kinds of grid

Both grids say where something is, but they name different things.



The star is in square C4. The star is at (3, 4), where line 3 meets line 4.

Two grids side by side. Left: a grid reference system with columns labelled A to E and rows labelled 1 to 5, where a star sits inside square C4. Right: a coordinate grid with both lines numbered from 0 to 5, where the star sits exactly on the crossing of line 3 and line 4, at (3, 4).

On the left is a **grid reference system**, the kind you used at Level 4. The letters across the top and the numbers down the side give each **space** its name. The star sits in square C4, and that is the best this grid can say: the star is somewhere inside that square.

On the right is a **coordinate grid**. The numbers 0, 1, 2, 3, 4, 5 are not names for squares. They sit on two number lines, and they name the **lines**. The star sits exactly where the line through 3 meets the line through 4, so its address is exact: **(3, 4)**.

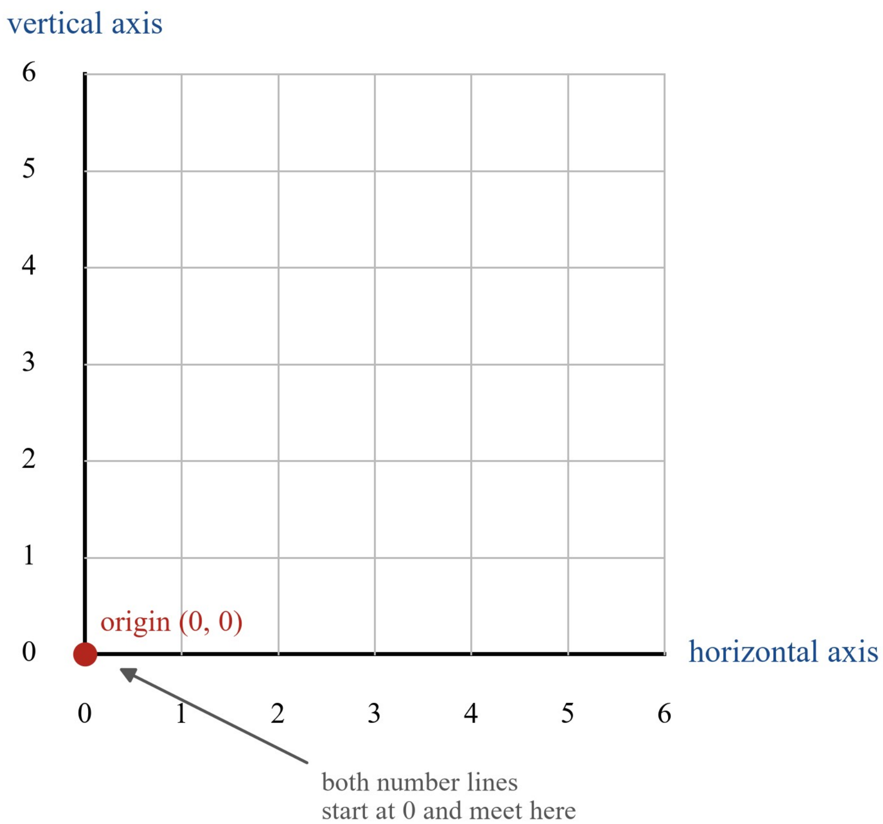
> **The big idea:** a grid reference names a square. A coordinate names a point.

Building a coordinate grid

The content description says *construct*, so here is how to build one.

1. Draw a number line from 0 to 6 running across, left to right. This is the **horizontal axis**.

2. Draw a second number line from 0 to 6 running straight up. It starts at the same 0 and meets the horizontal axis at a right angle. This is the **vertical axis**.
3. The two axes meet at the point (0, 0). This point is called the **origin** — the starting point for every position on the grid.
4. Draw a light line through each whole number on both axes: straight up from each number on the horizontal axis, and straight across from each number on the vertical axis.



A coordinate grid built from two number lines that start at 0 and meet at a right angle. The horizontal axis is numbered 0 to 6 along the bottom, the vertical axis is numbered 0 to 6 up the left side, light lines run through every whole number, and the origin (0, 0) is marked in red at the corner.

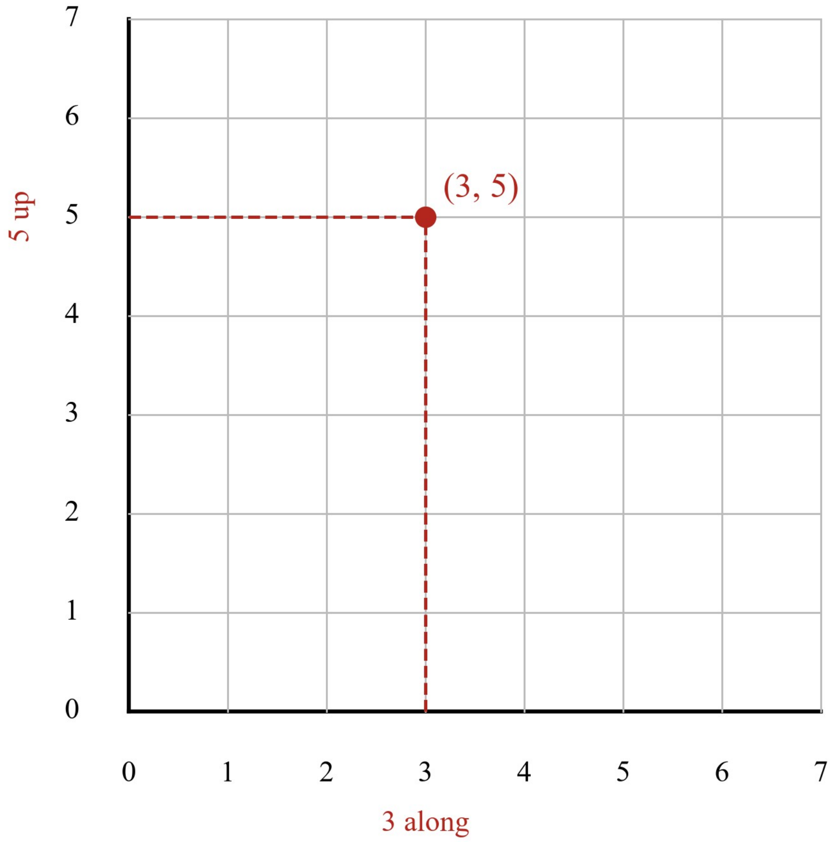
The numbers on the axes are just numbers on a number line: each one is one step further from 0 than the one before it. Every place where two of the light lines cross is a position we can name. At Level 5 we use whole numbers from 0 and up; at Level 6 the axes keep going in more directions (`VC2M6SP02`), so a well-built grid is worth having.

Writing a coordinate

A coordinate is two numbers written inside **brackets** with a **comma** between them: **(3, 5)**.

- The **first** number tells how far to go along the horizontal axis.
- The **second** number tells how far to go up the vertical axis.

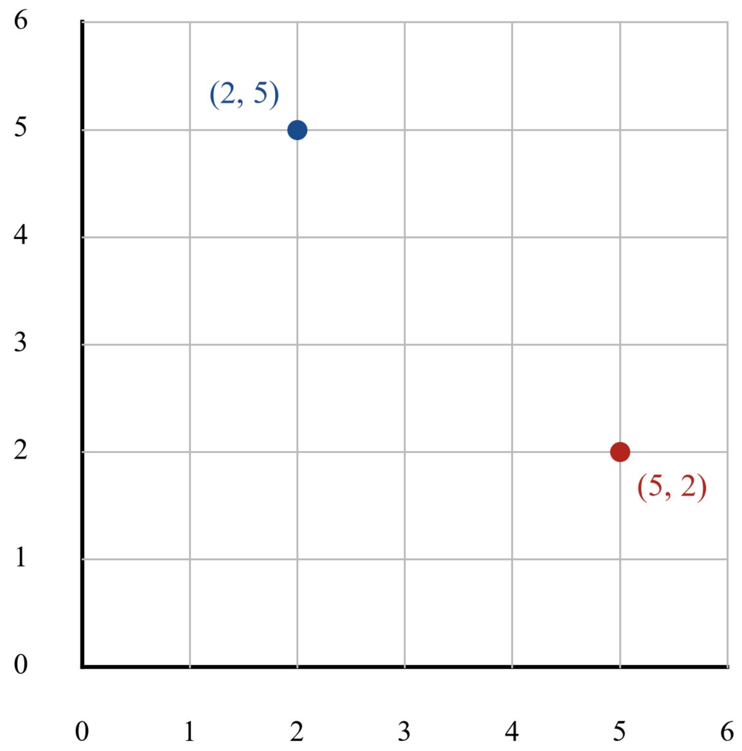
That order — horizontal first, vertical second — is the convention everyone uses. A handy way to say it is: *along first, then up*.



A coordinate grid from 0 to 7 with a red point at (3, 5). Dashed lines run from the point down to 3 on the horizontal axis and across to 5 on the vertical axis, showing how the coordinate is read.

To read the coordinate of a point, travel straight down to the horizontal axis and straight across to the vertical axis. In the figure, the point is above 3 and across from 5, so its coordinate is (3, 5).

Order matters. (2, 5) and (5, 2) use the same two numbers, but they name different points.

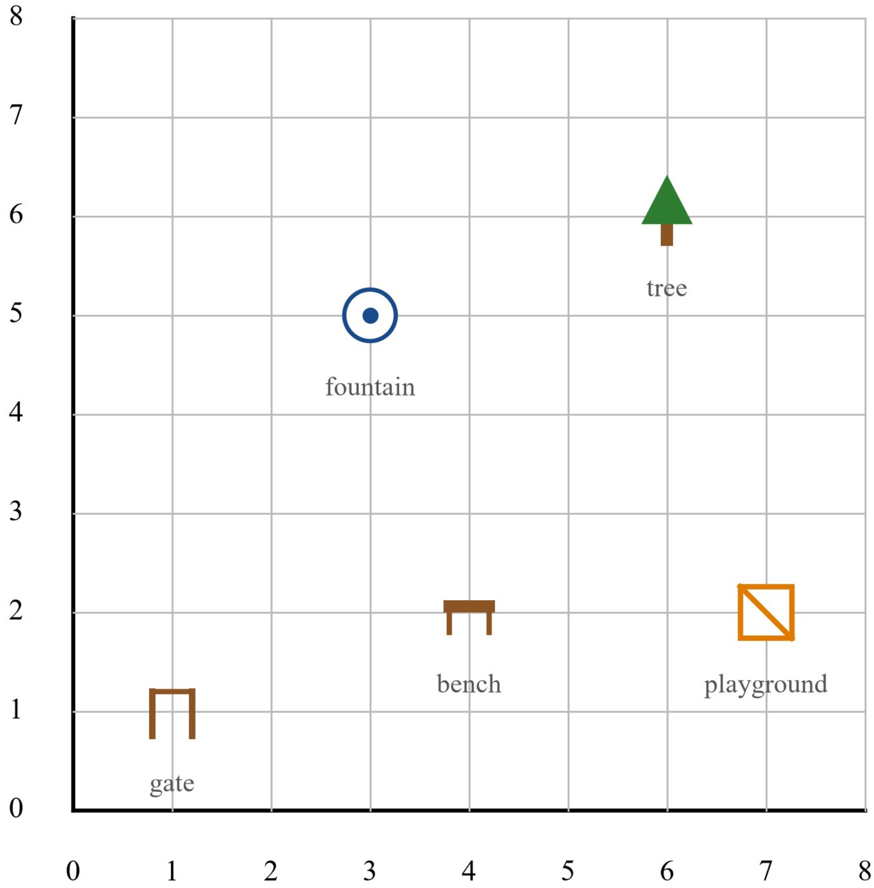


A coordinate grid from 0 to 6 showing two different points: (2, 5) in blue and (5, 2) in red, to show that swapping the numbers gives a different point.

Some positions sit on the axes themselves. (4, 0) means 4 along and 0 up: a point on the horizontal axis. (0, 6) sits on the vertical axis. The origin is (0, 0).

Positions on a map

A coordinate grid can be a map. Here is a park drawn on a grid.



A park map on a coordinate grid from 0 to 8. A gate is at (1, 1), a bench at (4, 2), a fountain at (3, 5), a tree at (6, 6) and a playground at (7, 2), each drawn as a small picture on its exact point.

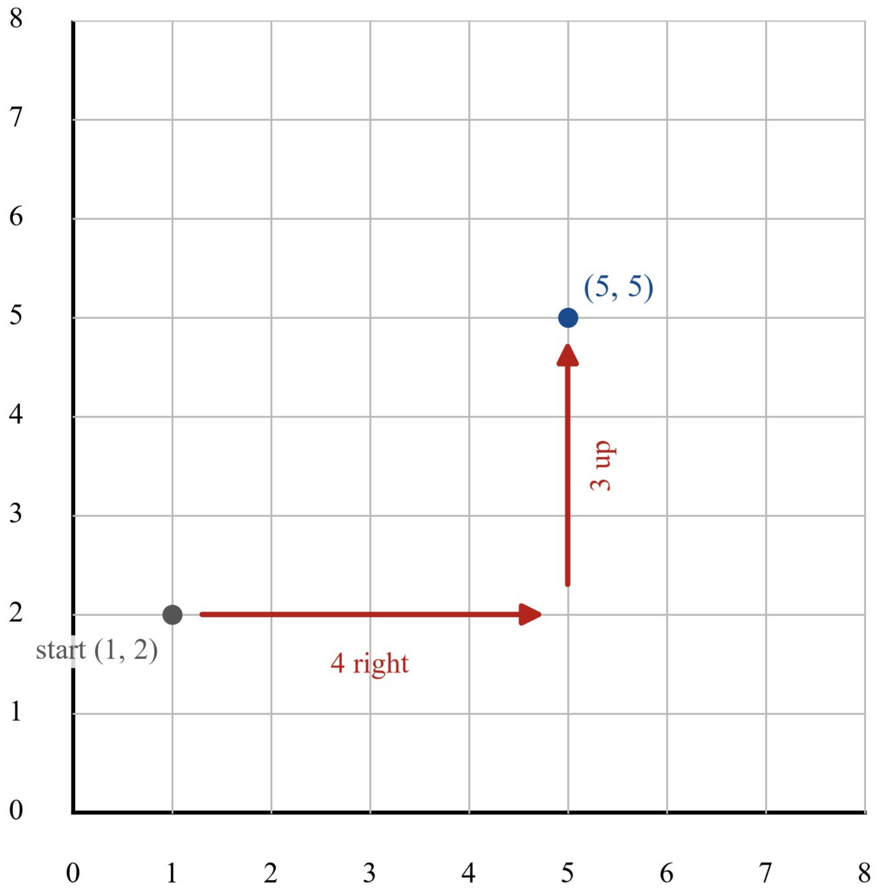
- The gate is at (1, 1).
- The bench is at (4, 2).
- The fountain is at (3, 5).
- The tree is at (6, 6).
- The playground is at (7, 2).

To find the fountain, start at the origin and go 3 along, then 5 up. To find the playground, go 7 along, then 2 up.

Describing movement

Coordinates also describe movement. A move on the grid is counted in steps along the grid lines: right, left, up or down. Each move changes the coordinate in a simple way.

Move	First number	Second number
right	goes up	no change
left	goes down	no change
up	no change	goes up
down	no change	goes down



A coordinate grid from 0 to 8 showing a path: a dot at the start (1, 2), a red arrow labelled "4 right" to (5, 2), then a red arrow labelled "3 up" to a blue dot at (5, 5).

From the start (1, 2):

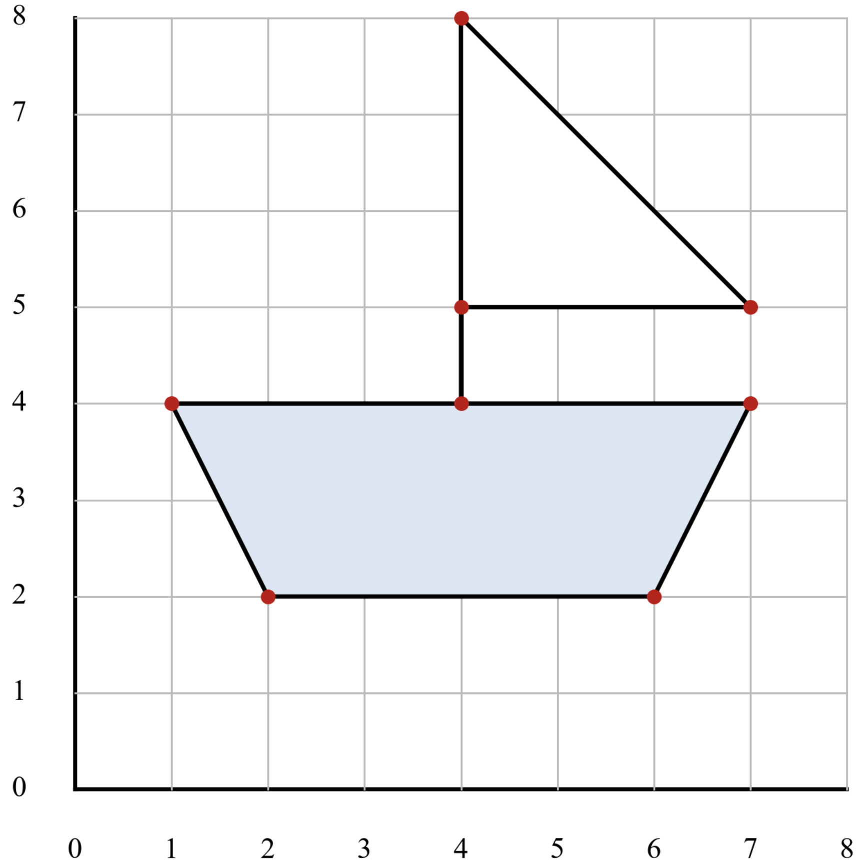
- **4 right** changes the first number: 1 + 4 = 5. The position is now (5, 2).
- **3 up** changes the second number: 2 + 3 = 5. The position is now (5, 5).

Moves may come in any order. From (1, 1), going 2 right then 4 up finishes at (3, 5) — and so does 4 up then 2 right. To describe the movement between two points, compare the numbers: from (1, 1) to (3, 5) the first number goes 1 → 3, which is 2 right, and the second goes 1 → 5, which is 4 up. So the movement is *2 right and 4 up*.

Drawing from coordinates

Coordinates can carry a whole picture. Here is the game:

1. Draw a straight-line picture on a coordinate grid, with every corner on a point where lines cross.
2. List the coordinates of the corners, in the order you join them.
3. Swap lists with a partner. Each of you draws from the other list only.
4. Compare the two drawings.



A sailboat drawn with straight lines on a coordinate grid from 0 to 8. The hull joins (1, 4), (7, 4), (6, 2) and (2, 2); the pole runs from (4, 4) to (4, 8); the sail joins (4, 5), (7, 5) and (4, 8). Every corner is marked with a red dot.

The sailboat is drawn from these lists:

- **Hull:** (1, 4), (7, 4), (6, 2), (2, 2), back to (1, 4).
- **Pole:** (4, 4), then (4, 8).
- **Sail:** (4, 5), (7, 5), (4, 8), back to (4, 5).

If your partner's drawing looks a little different from yours, hunt for the reason together: a point joined in the wrong order, a coordinate written with the numbers swapped — (5, 2) instead of (2, 5) — or a point missed out. Small mistakes in a coordinate make big changes in a picture. That is why the order, the brackets and the comma all matter.

A game for a coordinate grid

Hidden treasure (two players, one grid each)

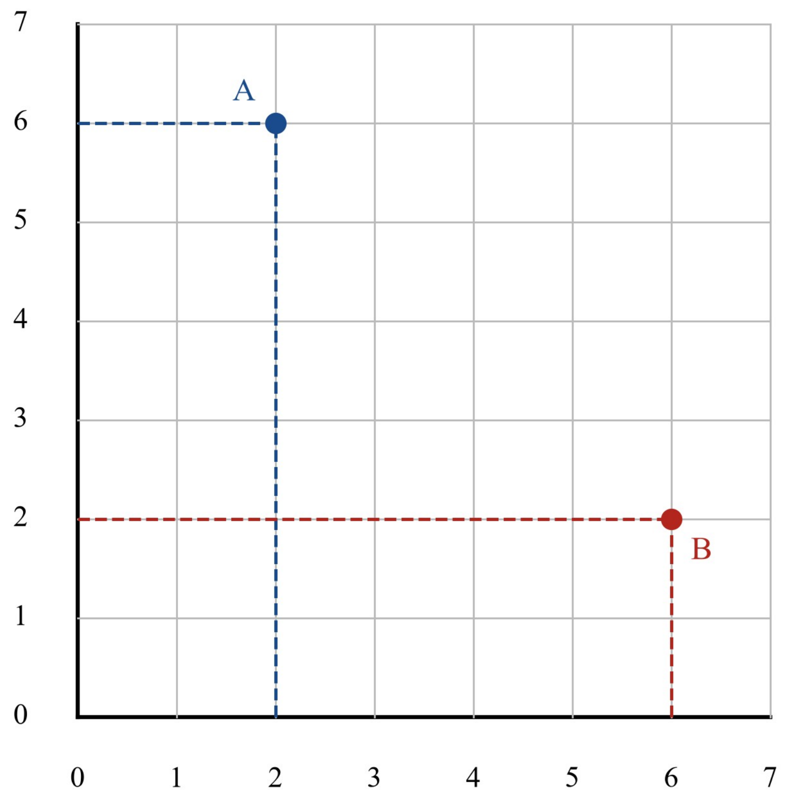
- Each player marks three points on their own grid, without showing the other player. These are the treasures.
- Players take turns to call a coordinate, such as (4, 3).
- The other player answers *hit* if a treasure sits exactly on that point, and *miss* if not.
- The first player to find all three treasures wins.

Think about how this game would work on the Level 4 kind of grid instead. Calling C4 would name a whole square, not an exact spot. On a coordinate grid every call is one exact point. That is what numbered lines give you.

Worked examples

Worked example 1 — reading coordinates

Points A and B are on the grid below. Write the coordinate of each point.



A coordinate grid from 0 to 7 with point A at (2, 6) in blue and point B at (6, 2) in red, each with dashed lines back to both axes.

Working	Comment
From A, straight down: 2. Straight across: 6.	Read each axis.
A is (2, 6).	Horizontal number first.
From B, straight down: 6. Straight across: 2.	Read each axis.
B is (6, 2).	Horizontal number first.

A and B use the same two numbers, but the order matters: (2, 6) and (6, 2) are different points.

Worked example 2 — plotting points

Plot (1, 4), (5, 4), (5, 7) and (1, 7) on a coordinate grid. Join them in order, then join the last point back to the first. Name the shape.

Working	Comment
(1, 4): 1 along, 4 up.	First number along, second up.
(5, 4): 5 along, 4 up.	Same height as (1, 4).
(5, 7): 5 along, 7 up.	Straight above (5, 4).
(1, 7): 1 along, 7 up.	Same height as (5, 7).
Join in order, and back to the start.	Four straight sides.

The shape is a **rectangle**: the two horizontal sides are 4 steps long and the two vertical sides are 3 steps long.

Worked example 3 — describing movement

On the park map above, describe the movement from the gate to the fountain.

Working	Comment
Gate: (1, 1). Fountain: (3, 5).	Read both coordinates.
Along: 1 → 3, so 2 steps right.	The first number goes up by 2.
Up: 1 → 5, so 4 steps up.	The second number goes up by 4.

The movement is **2 right and 4 up** — or 4 up and 2 right; both get you there.

Worked example 4 — following movement

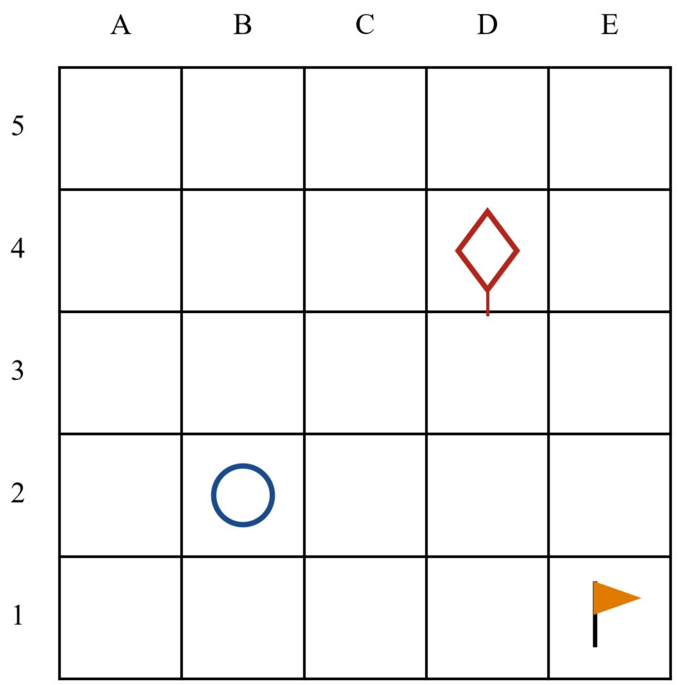
A toy robot starts at (2, 6). It moves 4 right, then 3 down. Where does it finish?

Working	Comment
Start: (2, 6).	
4 right: 2 + 4 = 6. Now (6, 6).	Right makes the first number go up.
3 down: 6 − 3 = 3. Now (6, 3).	Down makes the second number go down.

∴ The robot finishes at (6, 3).

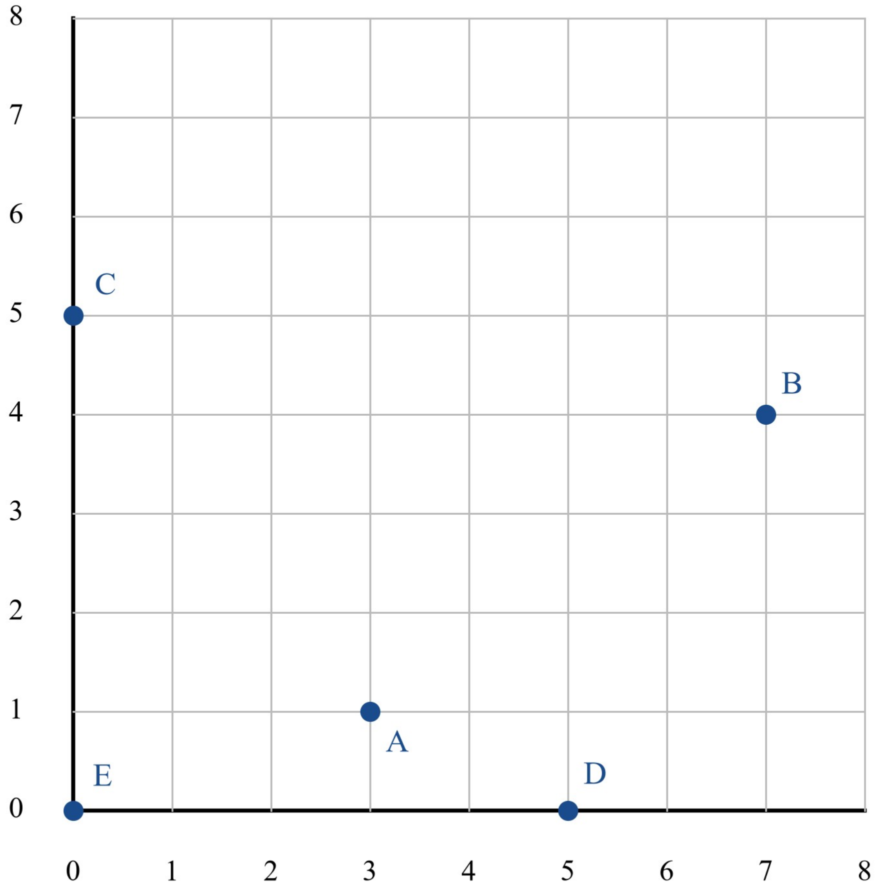
Practice questions

Q1. Warm-up from Level 4. The grid below is a grid reference system: the spaces carry the names. Write the grid reference of a. the ball, b. the kite, c. the flag.



A grid reference system with columns A to E across the top and rows 1 to 5 up the side. A ball sits in square B2, a kite in square D4 and a flag in square E1.

Q2. Write the coordinate of each point A, B, C, D and E.

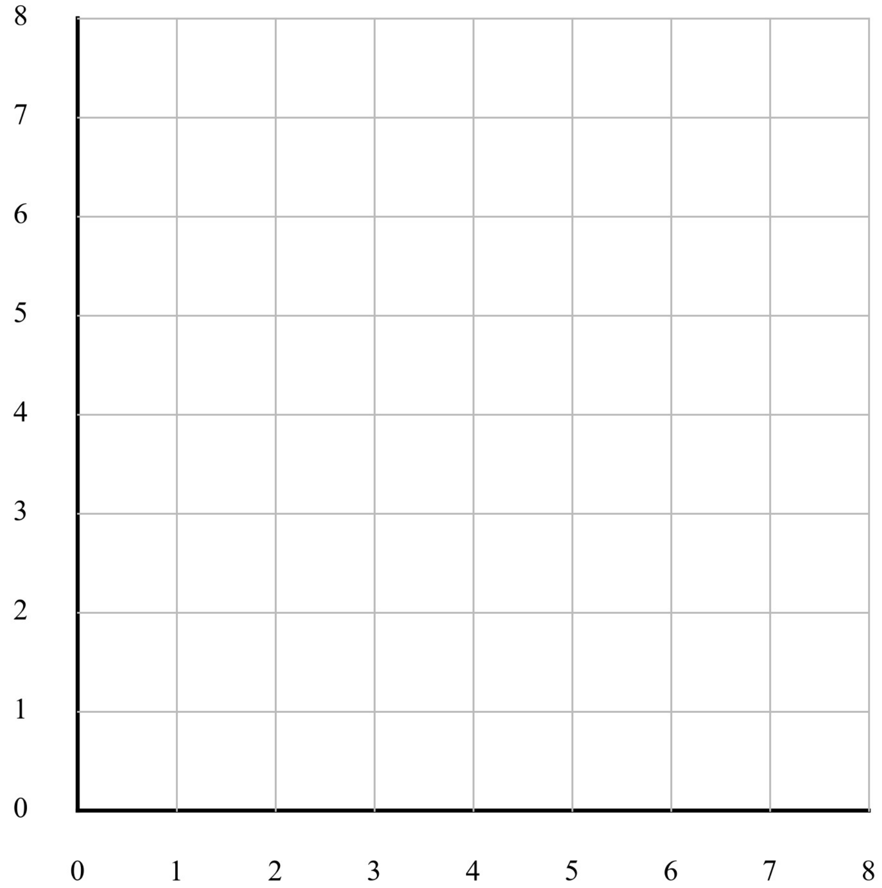


A coordinate grid from 0 to 8 with five blue points: A at (3, 1), B at (7, 4), C at (0, 5), D at (5, 0) and E at (0, 0).

Q3. On squared paper, build a coordinate grid the way the theory shows.

a. Draw a horizontal number line from 0 to 6 and a vertical number line from 0 to 6, starting at the same 0 and meeting at a right angle.
b. Draw a light line through each whole number on both axes.
c. Mark the origin and label it (0, 0).

Q4. On the grid below, plot (2, 3), (7, 3), (7, 6) and (2, 6). Join them in order, then join the last point back to the first. Name the shape.



A blank coordinate grid numbered 0 to 8 on both axes, ready for plotting.

Q5. On a fresh copy of the same grid, plot (3, 1), (7, 1) and (5, 5). Join them in order, then back to the start. Name the shape.

Q6. Mia says (4, 7) and (7, 4) name the same point, because they use the same two numbers. Is she right? Explain your answer.

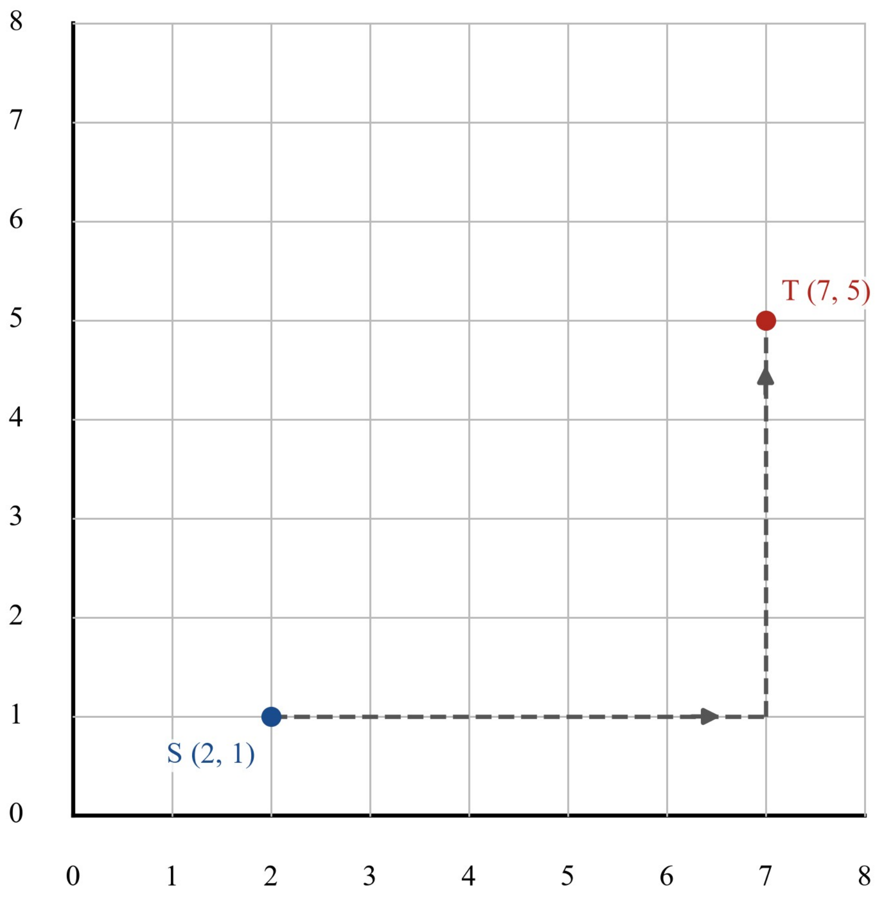
Q7. A point sits 5 along and 2 up from the origin. Ben writes its coordinate as (2, 5).

a. What mistake has Ben made?
b. Write the correct coordinate.

Q8. Copy and complete the table.

Start	Move	Finish
(2, 3)	4 right	
(7, 5)	3 left	
(1, 6)	2 down	
(0, 2)	5 up	

Q9. Describe the movement from S to T on the grid below, in two moves.



A coordinate grid from 0 to 8 with a dashed path from S (2, 1) along to (7, 1) and then up to T (7, 5), with arrows showing the direction of travel.

Q10. A toy robot starts at (3, 7). It moves 5 right, then 4 down.

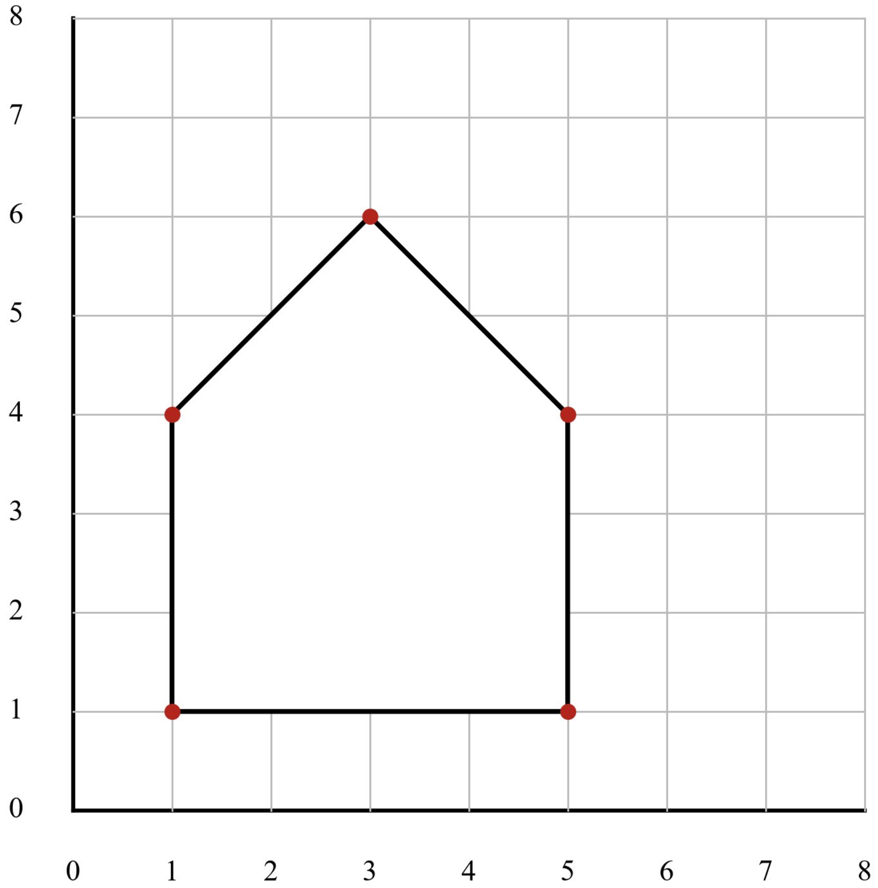
a. Where does it finish?
b. Describe the movement that takes it straight back to the start.

Q11. A drone finishes at (6, 5) after moving 2 right and 3 up. Where did it start?

Q12. Use the park map in the theory.

a. Write the coordinate of the tree, the fountain, the bench and the playground.
b. Describe the movement from the gate to the fountain.
c. Describe the movement from the bench to the playground.

Q13. The shape below is drawn on a coordinate grid. List the coordinates of its five corners in order, starting at the bottom-left corner and going around the shape.



A coordinate grid from 0 to 8 with a house shape drawn on it. The corners, marked with red dots, are (1, 1), (5, 1), (5, 4), (3, 6) and (1, 4).

Q14. Partner drawing, as in the theory.

a. Draw your own straight-line picture on a coordinate grid, with every corner on a point where lines cross.
b. List the coordinates of the corners in joining order, swap lists with a partner, and each draw from the other list only.
c. Compare your drawings. Give one reason they might look a little different.

Q15. Hidden treasure, as in the theory.

a. When you call (4, 3), what must your partner check?
b. Explain why a call on a coordinate grid is more exact than a call like C4 on a grid reference grid.

Q16. From (1, 0), Leah moves 3 right, then 5 up. From the same start, Tom moves 5 up, then 3 right.

a. Where does Leah finish?
b. Where does Tom finish?
c. What do you notice?

Q17. a. Plot (2, 0), (5, 0) and (8, 0). What do you notice about points whose second number is 0? b. What would you notice about points whose first number is 0, like (0, 3) and (0, 6)?

Q18. Alex plots a point 5 steps to the right of the origin and 2 steps up.

a. Write its coordinate.
b. He then moves the point 3 left and 6 up. Where is it now?

Answers

Q1. a. B2 b. D4 c. E1.

Q2. A (3, 1); B (7, 4); C (0, 5); D (5, 0); E (0, 0).

Q3. Check: the two number lines start at the same 0 and meet at a right angle; a light line runs through every whole number; the origin is marked (0, 0).

Q4. A rectangle (5 steps by 3 steps).

Q5. A triangle.

Q6. No. Order matters: (4, 7) is 4 along and 7 up, while (7, 4) is 7 along and 4 up — different points.

Q7. a. Ben swapped the numbers: he wrote the up-number first. b. (5, 2).

Q8. (6, 3); (4, 5); (1, 4); (0, 7).

Q9. 5 right, then 4 up.

Q10. a. (8, 3). b. 5 left and 4 up (in either order).

Q11. (4, 2).

Q12. a. Tree (6, 6); fountain (3, 5); bench (4, 2); playground (7, 2). b. 2 right and 4 up. c. 3 right.

Q13. (1, 1), (5, 1), (5, 4), (3, 6), (1, 4), back to (1, 1).

Q14. Check your drawings. c. A corner joined in the wrong order, a coordinate written with the numbers swapped, or a point missed out.

Q15. a. Whether a treasure sits exactly on the point (4, 3). b. (4, 3) names one exact point; C4 names a whole square, so you only know the treasure is in that square.

Q16. a. (4, 5). b. (4, 5). c. They finish at the same point: the order of the two moves does not change where you end up.

Q17. a. They all sit on the horizontal axis. b. They all sit on the vertical axis.

Q18. a. (5, 2). b. (2, 8).

Fully-worked solutions

Q1. The ball is in column B, row 2: B2. The kite is in column D, row 4: D4. The flag is in column E, row 1: E1. In a grid reference the letter (column) comes first.

Q2. A is above 3 and across from 1: (3, 1). B is above 7 and across from 4: (7, 4). C is 0 along and 5 up: (0, 5). D is 5 along and 0 up: (5, 0). E is 0 along and 0 up: (0, 0) — the origin.

Q3. A correct grid has: a horizontal number line 0–6; a vertical number line 0–6 starting at the same 0 and meeting it at a right angle; a light line through every whole number; and (0, 0) marked at the corner where the axes meet.

Q4. From (2, 3) to (7, 3) is 5 steps along; from (7, 3) to (7, 6) is 3 steps up; the opposite sides match. ∴ the shape is a rectangle.

Q5. (3, 1), (7, 1) and (5, 5) joined in order and back to the start give three straight sides. ∴ the shape is a triangle.

Q6. No. (4, 7) is the point 4 along and 7 up; (7, 4) is the point 7 along and 4 up. The two numbers are the same, but the order is part of the coordinate, so the points are different.

Q7. a. The point is 5 along and 2 up, so the first number must be 5. Ben wrote the up-number first and the along-number second — he swapped them. b. The correct coordinate is (5, 2).

Q8. (2, 3) and 4 right: 2 + 4 = 6, so (6, 3). (7, 5) and 3 left: 7 − 3 = 4, so (4, 5). (1, 6) and 2 down: 6 − 2 = 4, so (1, 4). (0, 2) and 5 up: 2 + 5 = 7, so (0, 7).

Q9. From S (2, 1) the path runs along to (7, 1): 7 − 2 = 5, so 5 right. Then it runs up to T (7, 5): 5 − 1 = 4, so 4 up. The movement is 5 right and 4 up.

Q10. a. 5 right: 3 + 5 = 8. 4 down: 7 − 4 = 3. ∴ (8, 3). b. To undo 5 right and 4 down, move 5 left and 4 up (in either order).

Q11. Undo the moves: 2 right becomes 2 left, and 3 up becomes 3 down. 6 − 2 = 4 and 5 − 3 = 2. ∴ the drone started at (4, 2).

Q12. a. Tree (6, 6); fountain (3, 5); bench (4, 2); playground (7, 2). b. Gate (1, 1) to fountain (3, 5): along 1 → 3 is 2 right; up 1 → 5 is 4 up. c. Bench (4, 2) to playground (7, 2): along 4 → 7 is 3 right; the second number does not change, so there is no up or down move.

Q13. Bottom-left corner (1, 1); along the bottom (5, 1); up the right side (5, 4); the roof point (3, 6); down the left side (1, 4); and back to (1, 1).

Q14. c. Two drawings differ when a corner is joined in the wrong order, when a coordinate is written with the numbers swapped — (5, 2) instead of (2, 5) — or when a point is missed out. That is exactly why the convention (along first, then up, inside brackets with a comma) matters.

Q15. a. Your partner checks whether one of their three treasures sits exactly on the point (4, 3): 4 along, 3 up. b. On a coordinate grid, (4, 3) is one exact point, so a hit tells you the treasure's whole address. On a grid reference grid, C4 is a whole square, so a hit only says the treasure is somewhere inside that square.

Q16. a. Leah: 1 + 3 = 4 along, 0 + 5 = 5 up: (4, 5). b. Tom: 0 + 5 = 5 up, then 1 + 3 = 4 along: (4, 5). c. The two finish at the same point. The order of the moves does not change the finishing position.

Q17. a. (2, 0), (5, 0) and (8, 0) all sit on the horizontal axis: when the second number is 0 there is no move up, so the point stays on the horizontal axis. b. When the first number is 0 there is no move along, so the point sits on the vertical axis.

Q18. a. 5 right of the origin and 2 up is (5, 2). b. 3 left: 5 − 3 = 2. 6 up: 2 + 6 = 8. ∴ the point is now at (2, 8).

Translations, reflections, rotations and symmetry

describe and perform translations, reflections and rotations of shapes, using dynamic geometry software where appropriate; recognise what changes and what remains the same, and identify any symmetries — VC2M5SP03

Level 5 achievement standard (extract): *They perform and describe the results of transformations and identify any symmetries.*

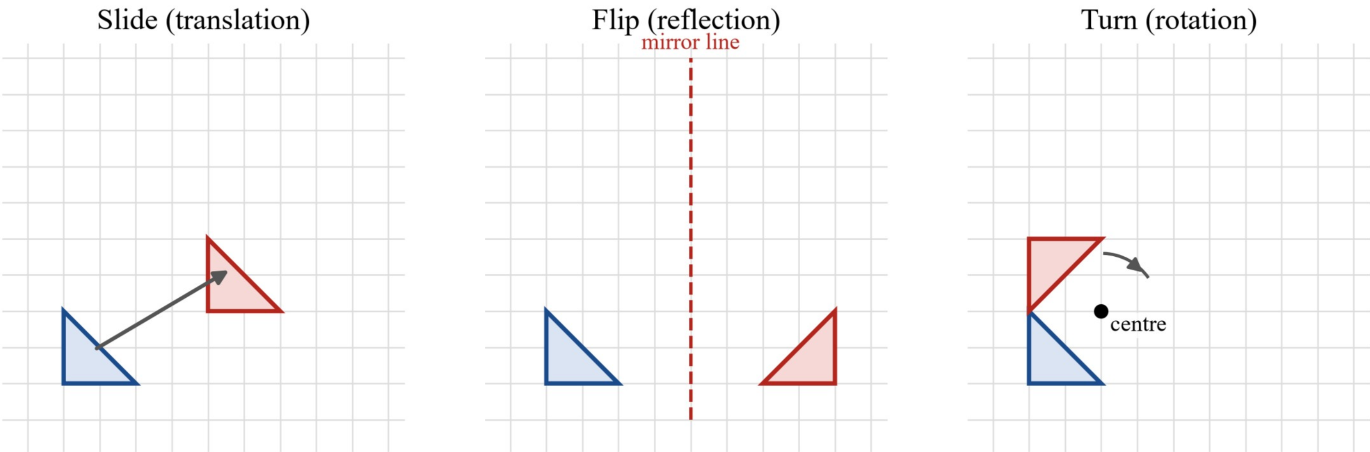
In this section, shapes get moving. There are three moves to learn — a **slide**, a **flip** and a **turn** — and their maths names are **translation**, **reflection** and **rotation**. Any move that carries a shape to a new place is called a **transformation**. The shape you start with is the **original**, and the shape after the move is its **image**.

You will also work out what each move changes and what it leaves the same, and you will spot **symmetry** — an idea you met in Year 4 — hiding inside the moves. On our grids we write a point as (across, up), with the across number first, exactly as in 6B.

Theory

The three moves at a glance

- A **translation** (slide) moves a shape in a straight line. Every point of the shape moves the same distance in the same direction.
- A **reflection** (flip) turns a shape over a line, the way a mirror does. The line is called the **mirror line**.
- A **rotation** (turn) spins a shape around a fixed point, called the **centre of rotation**.

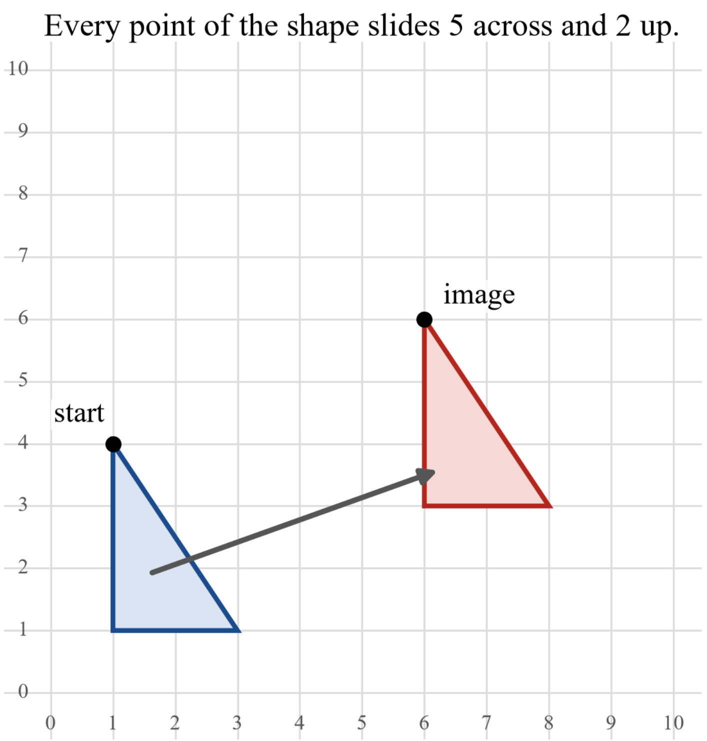


The same triangle shown three times: once slid up and to the right with an arrow (a slide, called a translation), once flipped across a dashed vertical mirror line (a flip, called a reflection), and once turned about a marked centre point with a curved arrow (a turn, called a rotation).

In every one of these moves, the image is the **same shape and the same size** as the original. Only the **position** (where the shape is) and the **orientation** (which way it faces) can change. That one sentence is the big idea of this section, so it is worth learning it word for word.

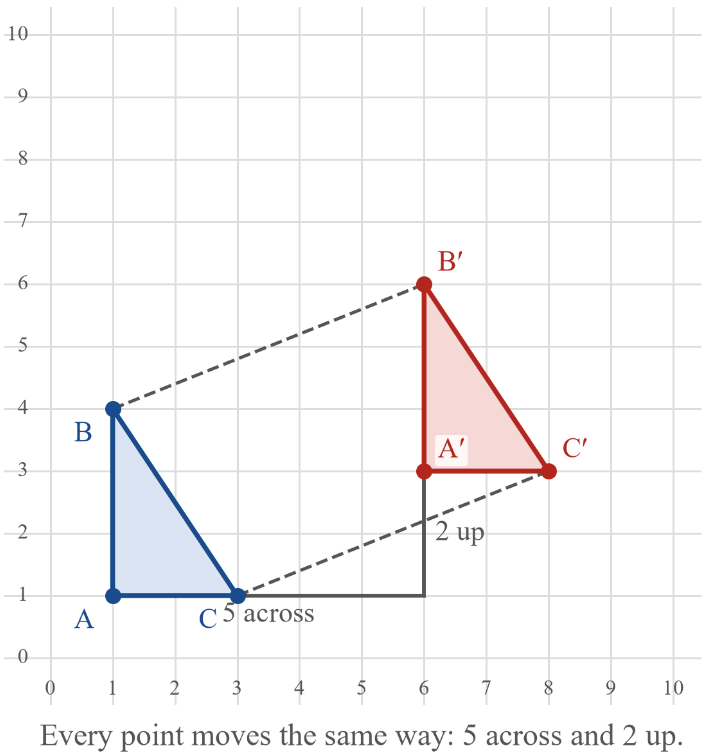
Slides — translations

Here a triangle has been translated on a numbered grid:



A triangle on a numbered square grid with its image after a slide; an arrow shows the shape has moved 5 squares across and 2 squares up, and the image is labelled.

To describe a translation, pick one point of the original and count across and up to the matching point of the image: 5 across and 2 up. Then check a second point. The next figure labels the matching points A and A′, B and B′, C and C′:

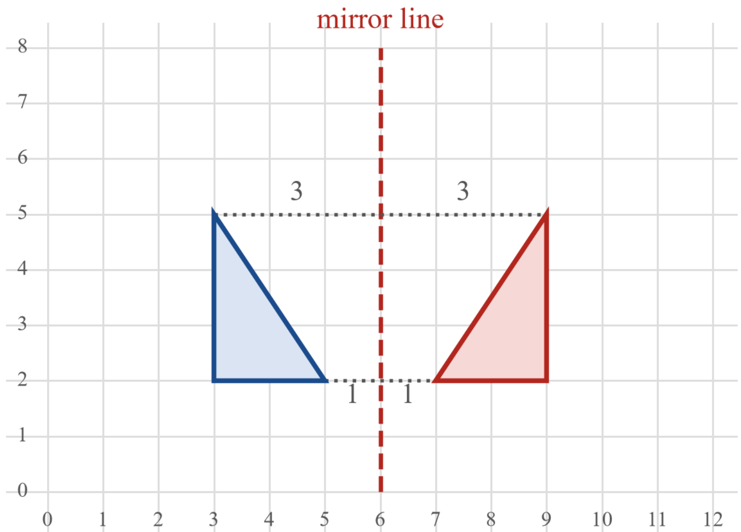


A triangle and its slide image on a numbered grid with matching points A, B, C and A′, B′, C′; dashed arrows join B to B′ and C to C′, and a counting path from A runs 5 across and then 2 up.

Every point of the shape has moved the same way — 5 across and 2 up — so the image faces the same way as the original. A slide never changes the orientation.

Flips — reflections

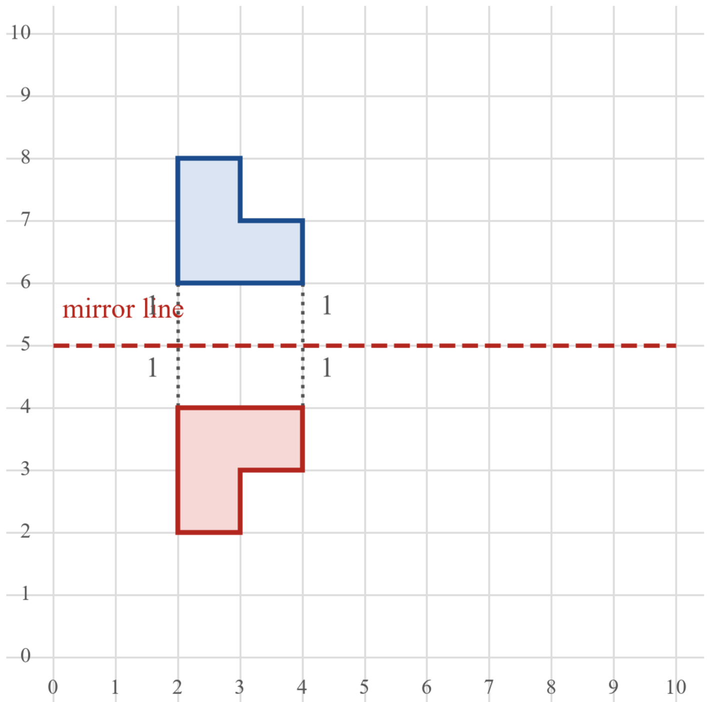
A reflection needs a **mirror line**. Each point of the shape lands the same distance away on the other side of the line:



Each point and its image are the same distance from the mirror line.

A triangle on the left of a dashed vertical mirror line at 6 on a numbered grid, with its flipped image on the right; dotted lines show each point and its image the same distance from the mirror line, 1 square for one pair and 3 for the other.

The point at (5, 2) sits 1 square from the mirror line, so its image sits 1 square over the other side, at (7, 2). The point at (3, 5) sits 3 squares from the line, so its image is 3 squares over at (9, 5). The mirror line can run any way. Ours so far has been a **vertical** line, running up and down; here is a flip over a **horizontal** mirror line, running side to side:



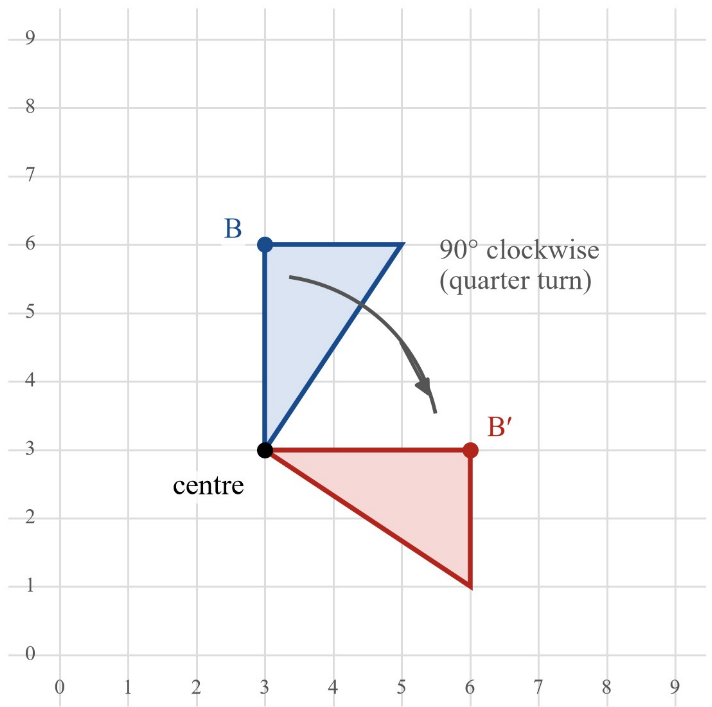
The boot flips over the mirror line. It keeps its shape and size.

A boot shape above a dashed horizontal mirror line at 5 on a numbered grid, with its flipped image below; dotted lines show matching points 1 square from the mirror line on each side.

The boot keeps its shape and its size, but it now faces the other way — the image is a mirror image. So a reflection changes the position **and** the orientation of a shape.

Turns — rotations

A rotation needs three facts: the **centre of rotation** (the point the shape turns about), the **direction**, and **how far** it turns. The direction is **clockwise** — the way the hands of a clock move — or **anticlockwise**, the other way. In 5D you began measuring angles in degrees, so a turn can be described either way: a **quarter turn** is 90°, a **half turn** is 180°, and a **three-quarter turn** is 270°.

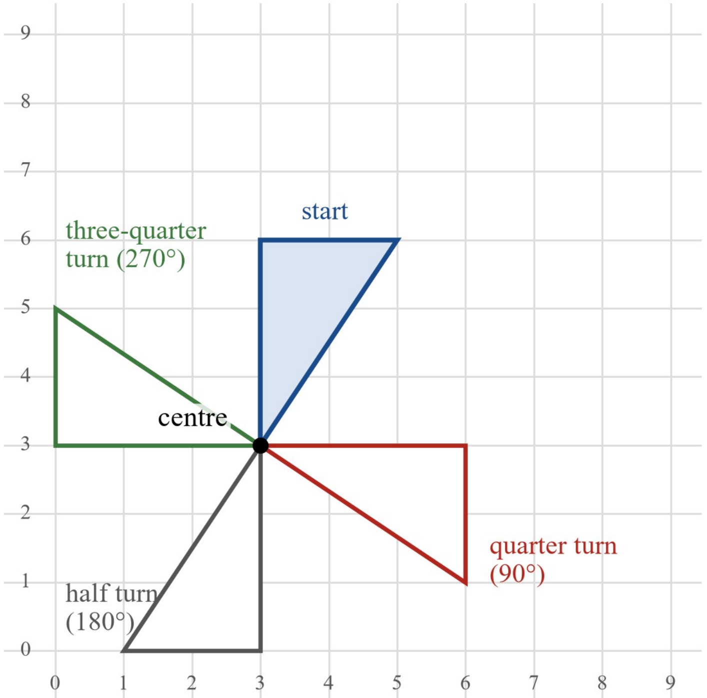


The shape turns around the centre point. Point B moves to B′.

A triangle on a numbered grid turning about a marked centre point; a curved arrow shows a quarter turn of 90 degrees clockwise, and the point B is carried to B′.

The shape turns around the centre point, and point B travels around to B′. Notice the corner of the shape that sits **on** the centre: it does not move at all. Every other point swings around the centre by the same turn.

The same shape, turned by three different amounts about the same centre:



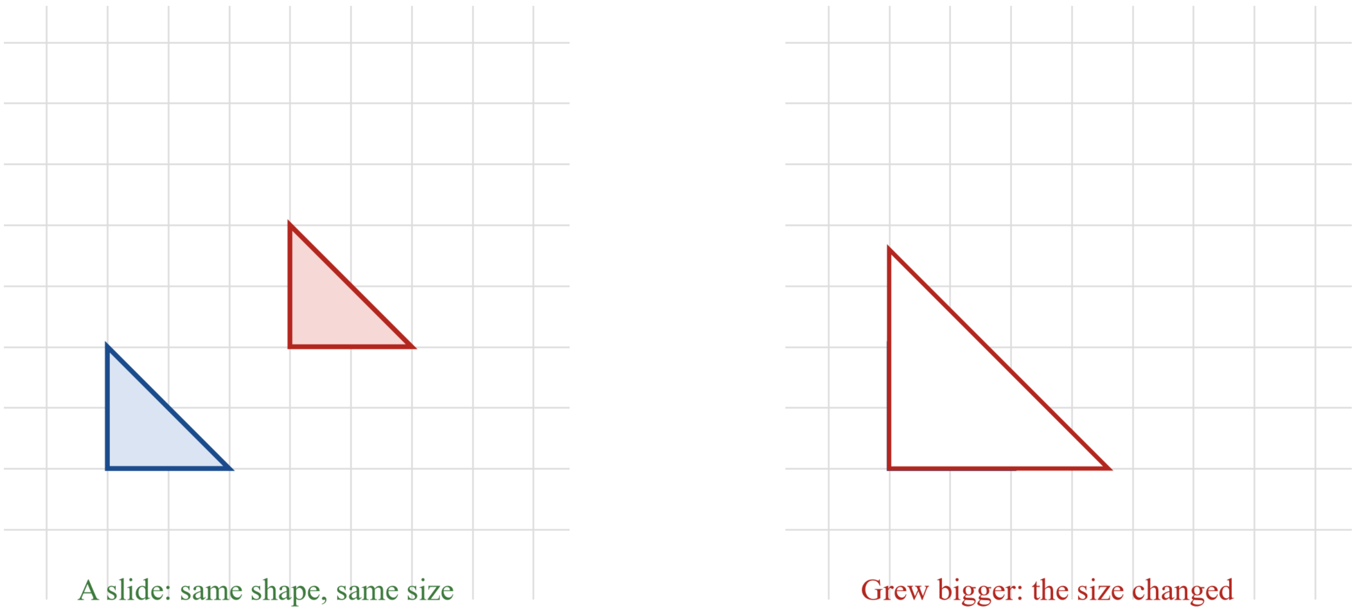
One triangle on a numbered grid together with three images of it turned about a shared centre: a quarter turn (90 degrees) in red, a half turn (180 degrees) in grey and a three-quarter turn (270 degrees) in green.

A turn changes the position and the orientation of a shape. As always, the shape and the size stay the same.

What changes, what stays the same

Move	Position	Orientation	Shape	Size
Slide (translation)	changes	stays the same	stays the same	stays the same
Flip (reflection)	changes	changes — the shape faces the other way	stays the same	stays the same
Turn (rotation)	changes (a point on the centre stays)	changes	stays the same	stays the same

If a picture shows the shape growing or shrinking, then it is **not** one of our three moves:

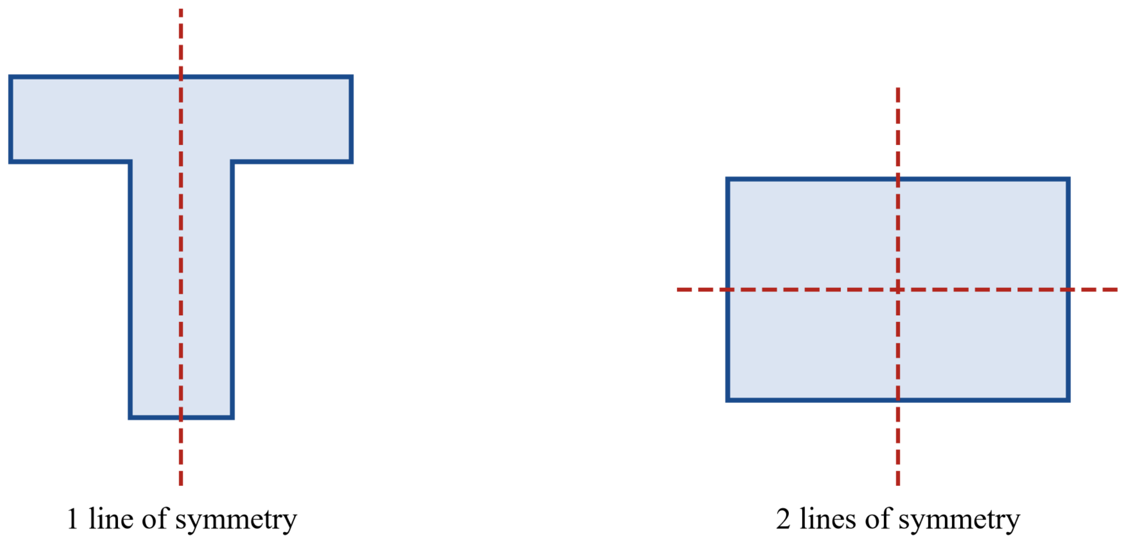


Two panels on square grids: the left shows a triangle and a same-sized copy after a slide; the right shows the triangle next to a copy that grew, where the size has changed.

Dynamic geometry software is a good way to explore all of this: draw the shape, choose a slide, a flip or a turn, and watch where the image lands. You can drag the mirror line or change the turn and see that the shape and size never change, only the position and the orientation.

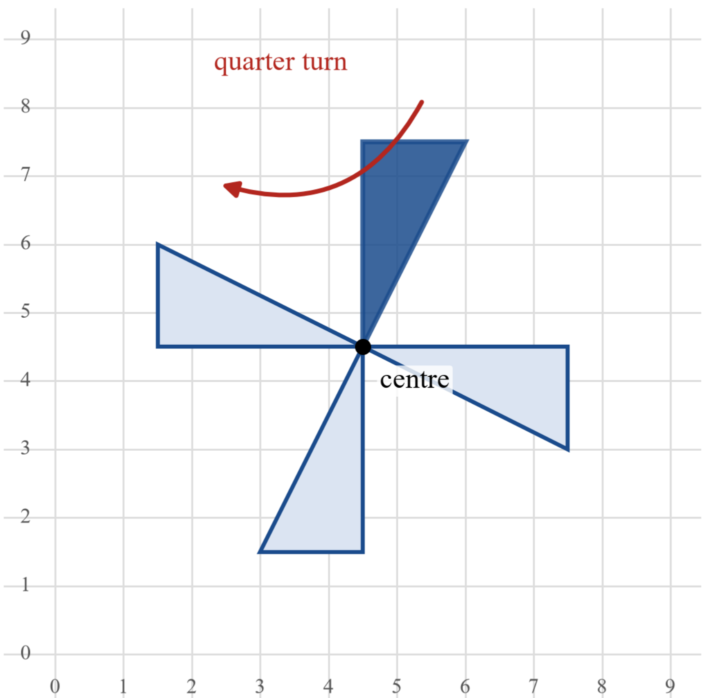
Symmetry — spotting it in the moves

In Year 4 you met two kinds of symmetry (`VC2M4SP04`). A shape has **line symmetry** if you can fold it along a line so the two halves match exactly; the fold line is a **line of symmetry**. A shape has **rotational symmetry** if it fits onto itself after a turn of less than a full turn.



Two shapes with their lines of symmetry drawn as dashed lines: a capital T with one vertical line of symmetry, and a rectangle with two lines of symmetry, one vertical and one horizontal.

The T folds onto itself along one line. The rectangle has two lines of symmetry — fold along either and the halves match.

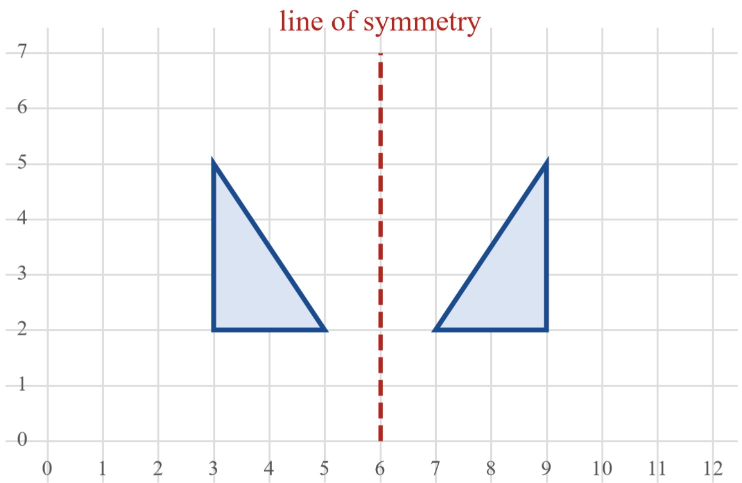


After a quarter turn, every blade sits where the next blade was — the shape fits onto itself.

A four-bladed pinwheel shape on a numbered grid with its centre marked; a curved arrow shows that after a quarter turn each blade sits where the next blade was, so the shape fits onto itself.

The pinwheel fits onto itself after a quarter turn, so it has rotational symmetry — but it has no line of symmetry. There is no fold line where the halves match. A shape can have one kind of symmetry, both kinds, or no symmetry.

Transformations can **make** symmetry too. Take a shape and its reflection, and look at the pair as one picture:



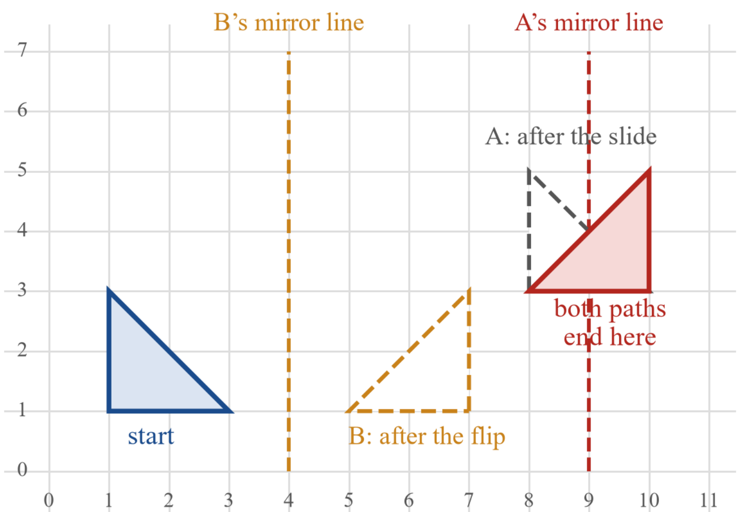
A shape and its reflection together make a picture with line symmetry.

Two triangles on a numbered grid facing each other across a dashed vertical line at 6; the pair forms one picture whose line of symmetry is the dashed line.

The mirror line is now a **line of symmetry of the whole picture**: fold along it and the two triangles match. In the same way, turning a shape about a centre several times builds a picture with rotational symmetry — like the pinwheel above, which is one blade turned by quarter turns.

Putting moves together

Moves can be joined into a **combination**, done one after the other. Here two different combinations start from the same triangle and end at the same image:



Two different combinations of moves, with the same ending image.

A numbered grid showing one starting triangle and two paths of moves that both end at the same red image: path A slides then flips across the mirror line at 9, path B flips across the mirror line at 4 then slides, with the middle shapes drawn as dashed outlines.

- **Path A:** slide 7 across and 2 up, then flip in the mirror line at 9.
- **Path B:** flip in the mirror line at 4, then slide 3 across and 2 up.

Both paths land on exactly the same ending image. Different combinations of transformations can produce the same result — and knowing that lets you set puzzles for each other.

Try it with tracing paper or pattern blocks. Trace around a shape. Do one move, trace the image in a new colour. Do another move, trace again in another colour. Then copy **only** the start and the end onto a fresh sheet and challenge a classmate to find a combination that gets from one to the other. Compare the combinations you each found — they may not be the same, and that is the point.

Worked examples

Worked example 1 — step by step: describe a translation

A slide takes the triangle (1, 1), (1, 4), (3, 1) to the triangle (6, 3), (6, 6), (8, 3). Describe the translation.

Working	Comment
(1, 1) → (6, 3): 5 across, 2 up	Pick one matching pair of points.
(1, 4) → (6, 6): 5 across, 2 up	Check a second pair.
(3, 1) → (8, 3): 5 across, 2 up	And a third — in a slide they all match.

∴ The translation is a slide of 5 across and 2 up.

Worked example 2 — step by step: draw a reflection

Reflect the triangle (3, 2), (3, 5), (5, 2) in the vertical mirror line at 6, as in the flip figure above.

Working	Comment
(5, 2) is 1 square from the line, so its image is 1 over the other side: (7, 2).	Count to the mirror line, then the same again.
(3, 5) is 3 from the line, so its image is (9, 5).	Same rule.
(3, 2) is 3 from the line, so its image is (9, 2).	Same rule.
Join (7, 2), (9, 5) and (9, 2).	The image is the mirror copy.

∴ The image is the triangle (7, 2), (9, 5), (9, 2) — same shape, same size, facing the other way.

Worked example 3 — step by step: describe a rotation

Describe the turn in the quarter-turn figure above.

Working	Comment
The point (3, 3) has not moved.	The centre of rotation is (3, 3).
B at (3, 6) has swung around to B′ at (6, 3).	The shape has turned the way clock hands move — clockwise.
The turn from B to B′ is a right angle, 90°.	A right angle of turn is a quarter turn (5D).

∴ The rotation is a quarter turn (90°) clockwise about the centre (3, 3).

Worked example 4 — step by step: what changed, what stayed the same?

Look again at the slide of 5 across and 2 up. For that move, say what changed and what stayed the same.

Working	Comment
The position changed: every point moved.	The image sits somewhere new.
The orientation stayed the same: the image faces the same way.	Slides never turn or flip a shape.
The shape stayed the same, and the size stayed the same.	All three moves keep shape and size.

∴ The slide changed the position only; the orientation, the shape and the size all stayed the same.

Worked example 5 — on your own: two ways to the same image

In the combinations figure, describe both paths from the start to the ending image, and check that each really ends at the triangle (8, 3), (10, 5), (10, 3).

Path A: slide 7 across and 2 up gives (8, 3), (8, 5), (10, 3); flipping in the line at 9 sends (8, 3) to (10, 3), (8, 5) to (10, 5) and (10, 3) to (8, 3). Path B: flipping in the line at 4 gives (7, 1), (7, 3), (5, 1); sliding 3 across and 2 up gives (10, 3), (10, 5), (8, 3).

∴ Both combinations end at (8, 3), (10, 5), (10, 3) — the same image from two different paths.

Worked example 6 — on your own: find the symmetry in a picture

Look at the picture of a triangle and its reflection. Name the symmetry of the whole picture and say where it is.

Folding along the mirror line at 6 makes the two triangles match exactly.

∴ The whole picture has line symmetry, and its line of symmetry is the mirror line. (The single triangles have no line symmetry — the symmetry belongs to the picture the reflection made.)

Practice questions

Q1. Name the transformation described.

a. A shape turns about a fixed point.
b. A shape flips over a line.
c. Every point of a shape moves the same distance in the same direction.

Q2. Look at the slide figure with the triangle (1, 1), (1, 4), (3, 1) and its image.

a. Describe the translation.
b. Write the coordinates of the image of the point (1, 4).

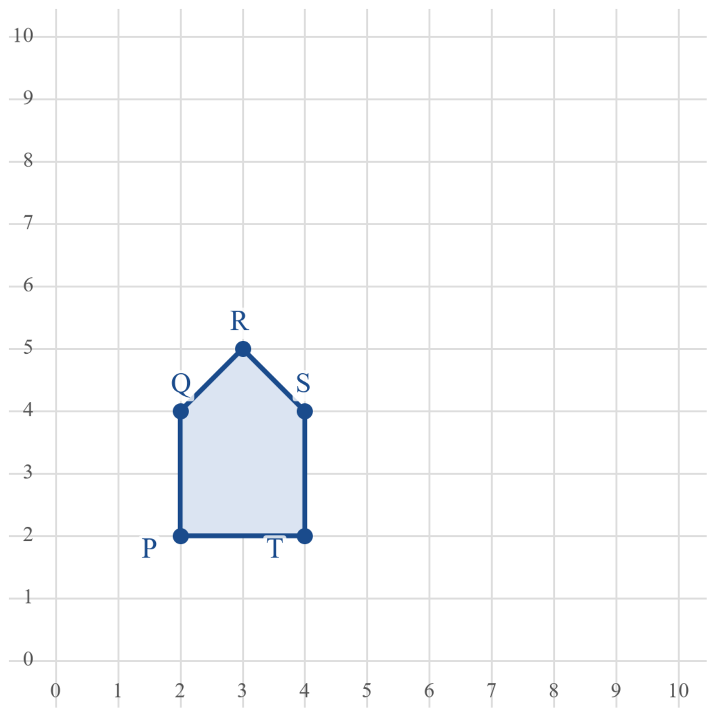
Q3. A translation slides every point 4 across and 3 up.

a. Where does the point (2, 1) land?
b. Where does the triangle (1, 1), (1, 3), (3, 1) land?
c. Does the image face the same way as the original, or a different way?

Q4. Look at the figure of the flip over the vertical mirror line at 6.

a. Which point of the original is closest to the mirror line, and how far away is it?
b. How far is the image of (3, 5) from the mirror line?
c. Name two things the flip did **not** change.

Q5. Copy the grid and the house PQRST onto grid paper. Draw the image of the house after a reflection in the vertical mirror line at 6. Write the coordinates of the five image points.



Copy this grid and the house onto grid paper.

A house shape on a numbered square grid with its five corners labelled P, Q, R, S and T, ready to be copied onto grid paper.

Q6. Using your copy from Q5, now draw the image of the **original** house after a slide of 4 across and 3 up. Write the coordinates of the five image points.

Q7. Look at the quarter-turn figure. Describe the rotation in full: centre, direction and amount of turn.

Q8. Look at the figure with the quarter, half and three-quarter turns.

a. Which image is the half turn? Which is the three-quarter turn?
b. Is any image a different size from the start? How do you know without measuring?

Q9. True or false? If false, fix the sentence.

a. A slide changes the orientation of a shape.
b. A flip changes the size of a shape.
c. In all three moves, the image is the same size as the original.
d. In a turn, every point of the shape moves.
e. A shape and its image always face the same way.

Q10. Look at the two-panel figure. Which panel does **not** show one of the three moves? Explain.

Q11.

a. How many lines of symmetry does the T have?
b. How many does the rectangle have?
c. On grid paper, draw a square 4 by 4 and draw **all** of its lines of symmetry. How many are there?

Q12. Look at the pinwheel figure.

a. After what turn does the pinwheel first fit onto itself?
b. Does the pinwheel have rotational symmetry?
c. Does it have line symmetry? How could you check?

Q13. Look at the figure of two triangles facing each other across the dashed line at 6.

a. What kind of symmetry does the whole picture have?
b. Where is it?
c. Name one thing that changed from the left triangle to the right one.

Q14. Look at the combinations figure.

a. Describe combination A (two moves, in order).
b. Describe combination B.
c. What do you notice about the two ending images?

Q15. On grid paper, copy the house PQRST. Choose your own slide, draw its image, then flip that image in a vertical mirror line you choose and draw the final result. Then find a **different** combination of moves that ends at the same final result, and trace it in another colour.

Q16. Mai says, "In a flip, every point of the shape moves the same distance in the same direction." Is Mai right? Which move do her words actually describe? Use the flip figure to explain.

Q17. You have checked Q5 by hand. Write the steps you would follow in dynamic geometry software to check it again.

Q18.

a. A shape is slid 2 across and 5 up, then slid 3 across and 1 up. What single slide would give the same image?
b. A shape is flipped in a vertical mirror line, then flipped in the **same** line again. Where does it end up? Explain why.

Answers

Q1. a. Rotation (turn). b. Reflection (flip). c. Translation (slide).

Q2. a. 5 across and 2 up. b. (6, 6).

Q3. a. (6, 4). b. (5, 4), (5, 6), (7, 4). c. The same way — a slide keeps the orientation.

Q4. a. (5, 2), 1 square away. b. 3 squares. c. The shape and the size.

Q5. (10, 2), (10, 4), (9, 5), (8, 4), (8, 2).

Q6. (6, 5), (6, 7), (7, 8), (8, 7), (8, 5).

Q7. A quarter turn (90°) clockwise about the centre (3, 3).

Q8. a. Half turn: the grey image; three-quarter turn: the green image. b. No — a turn never changes the size, so every image is the same size as the start.

Q9. a. False — a slide keeps the orientation. b. False — a flip keeps the size. c. True. d. False — a point sitting on the centre does not move. e. False — flips and turns change which way the shape faces.

Q10. The right panel — the copy grew, so the size changed, and all three moves keep the size the same.

Q11. a. 1. b. 2. c. 4.

Q12. a. A quarter turn (90°). b. Yes. c. No — there is no fold line where the halves match.

Q13. a. Line symmetry. b. Along the mirror line at 6. c. The orientation (it faces the other way) — and the position.

Q14. a. Slide 7 across and 2 up, then flip in the mirror line at 9. b. Flip in the mirror line at 4, then slide 3 across and 2 up. c. They are the same image.

Q15. Answers vary; a sample is in the solutions.

Q16. No; her words describe a slide (translation).

Q17. Answers vary; a sample is in the solutions.

Q18. a. 5 across and 6 up. b. Back where it started.

Step-by-step solutions

Q1. a. Turning about a fixed point is a **rotation**. b. Flipping over a line is a **reflection**. c. Moving every point the same distance in the same direction is a **translation**.

Q2. a. Counting from (1, 1) to (6, 3): 5 across and 2 up; the other points agree. b. (1, 4) → (6, 6), 5 across and 2 up.

Q3. a. (2 + 4, 1 + 3) = (6, 4). b. (1 + 4, 1 + 3) = (5, 4), (1 + 4, 3 + 3) = (5, 6), (3 + 4, 1 + 3) = (7, 4). c. The same way: a slide changes the position only, never the orientation.

Q4. a. (5, 2) — the figure marks it 1 square from the line. b. (3, 5) is 3 from the line, so its image is 3 from the line too. c. The shape and the size never change in a flip.

Q5. Count each point to the mirror line at 6, then the same again the other side: P(2, 2) → (10, 2), Q(2, 4) → (10, 4), R(3, 5) → (9, 5), S(4, 4) → (8, 4), T(4, 2) → (8, 2). Join them in order: the image is the same house, facing the other way.

Q6. Add 4 across and 3 up to every point: P(2, 2) → (6, 5), Q(2, 4) → (6, 7), R(3, 5) → (7, 8), S(4, 4) → (8, 7), T(4, 2) → (8, 5).

Q7. The centre is the point that did not move, (3, 3). B swung to B′ the clockwise way, through a right angle. ∴ A quarter turn (90°) clockwise about the centre (3, 3).

Q8. a. The grey image is the half turn (180°); the green image is the three-quarter turn (270°). b. No: a turn keeps the shape and the size, so every image is exactly the start's size.

Q9. a. False — a slide keeps the orientation the same. b. False — a flip keeps the size the same. c. True — the shape and the size stay the same in all three moves. d. False — in the quarter-turn figure the corner on the centre stayed put, so not every point moved. e. False — a flip or a turn leaves the image facing a different way.

Q10. The right panel. The second triangle grew, so the size changed; a slide, a flip and a turn all keep the size the same, so growing is not one of them.

Q11. a. One — the vertical fold. b. Two — one each way through the middle. c. Four: two through the middles of opposite sides, and two from corner to corner.

Q12. a. A quarter turn (90°): each blade lands where the next blade was. b. Yes — fitting onto itself after a turn of less than a full turn is exactly rotational symmetry. c. No. Folding along any line leaves the blades sticking out the wrong way, so no fold makes the halves match.

Q13. a. Line symmetry. b. The line of symmetry is the mirror line at 6 — folding along it makes the triangles match. c. The orientation: the right triangle faces the other way (its position changed too).

Q14. a. Slide 7 across and 2 up, then flip in the mirror line at 9. b. Flip in the mirror line at 4, then slide 3 across and 2 up. c. The two ending images are exactly the same triangle — different combinations of transformations can produce the same result.

Q15. Sample: slide 2 across and 2 up to get (4, 4), (4, 6), (5, 7), (6, 6), (6, 4), then flip in the mirror line at 6 to finish at (8, 4), (8, 6), (7, 7), (6, 6), (6, 4). A different combination to the same finish: flip in the mirror line at 5 first, giving (8, 2), (8, 4), (7, 5), (6, 4), (6, 2), then slide 2 up. Any correct pair of combinations earns the mark; checking that both endings land on the same five points is the skill.

Q16. No. In the flip figure the point at (5, 2) moved 2 squares and the point at (3, 5) moved 6, so the distances are not the same — that alone shows a flip is not what Mai described. Her words, "the same distance in the same direction", exactly describe a **translation** (slide).

Q17. Sample: draw the grid lines and the house PQRST; draw the mirror line at 6; use the reflection tool with that mirror line; compare the software's image with the one you drew by hand; check a pair of matching points to see each is the same distance from the mirror line. Any sensible sequence that reflects the house in the line at 6 and compares earns the mark.

Q18. a. The across moves add (2 + 3 = 5) and the up moves add (5 + 1 = 6), so one slide of 5 across and 6 up gives the same image. b. Back where it started: the first flip puts every point the same distance over the other side, and the second flip in the same line carries it straight back. Two flips in the same mirror line undo each other.

The idea of interpreting animal tracks (VC2M5SP03.E05) is not covered in this section, under the house rule that Aboriginal and Torres Strait Islander content is excluded; every other part of VC2M5SP03 is drawn on throughout.

Test

Test T6 · Chapter 6 — Space

Mathematics Level 5 (Year 5) · Victorian Curriculum 2.0

Codes assessed: `VC2M5SP01` · `VC2M5SP02` · `VC2M5SP03`

Name: ______________________________ Date: ______________

Total marks	15
Guidance duration	20 minutes
Timing	This is a classroom check, not an exam. Guidance is about 1 minute per mark plus 5 minutes reading. There is no strict time limit. Your teacher will let you finish.
Equipment	You will need a ruler, grid paper, and scissors for one net item. You will also need a pencil.
Calculators	None of the content descriptions in this test says "without a calculator", so a calculator is allowed. You do not need one for any question in this test.

Attempt every question. Show your working where the question asks for it.

Question 1 — Objects and their nets (5 marks)

(a) A triangular prism is cut open along some of its edges and opened out flat. Which set of shapes is its net made of? (1 mark)

A. 5 rectangles

B. 3 rectangles and 2 triangles

C. 4 triangles and 1 square

D. 6 triangles

(b) A flat shape is made of 1 square with a triangle on each of its 4 sides. (2 marks)

i. Name the solid the shape folds into.

ii. How many faces does that solid have?

(c) You will need grid paper and scissors for this part. Handle the scissors safely. (2 marks)

On grid paper, draw a flat shape made of 6 squares that you **predict** will fold into a cube. Cut it out and fold it to test your prediction.

Prediction and reason: ____

Did the fold match your prediction? ____________________________________

Question 2 — Grid coordinate systems (5 marks)

(a) On grid paper, construct a coordinate grid. (2 marks)

- Draw a horizontal number line from 0 to 6 and a vertical number line from 0 to 6. The two lines start at the same 0 and meet at a right angle.
- Draw a light line through each whole number on both axes.
- Mark the origin and label it (0, 0).

(b) A point sits 5 along the horizontal axis and 2 up the vertical axis from the origin. Write its coordinate. (1 mark)

(c) A toy robot starts at the point (1, 5). It moves 4 right, then 2 down. (2 marks)

i. Where does the robot finish?

ii. Describe the movement that takes the robot straight back to the start.

Question 3 — Translations, reflections, rotations and symmetry (5 marks)

(a) Write the maths name for each move. (1 mark)

i. A slide is a ______________________.

ii. A flip is a ______________________.

iii. A turn is a ______________________.

(b) On your grid from Question 2, draw a triangle with corners at (0, 1), (2, 1) and (0, 3). Reflect the triangle in the vertical mirror line at 3: draw the image, then write the coordinates of its three corners. (2 marks)

(c) A shape is moved by a slide, a flip or a turn. Write one thing about the shape that **never** changes in any of the three moves. (1 mark)

(d) How many lines of symmetry does a square have? (1 mark)

Total: 15 marks

Solutions

Teacher-facing. Test T6 is a classroom check, not an exam: a 20-minute guidance duration (about 1 minute per mark plus 5 minutes reading), ruler, grid paper and scissors for one net item permitted, and none of the three content descriptions says “without a calculator”, so no question is calculator-free. All coordinates in this paper are whole numbers in the first quadrant, on lines numbered from zero, as `VC2M5SP02` requires; four-quadrant and negative coordinates are Level 6 (`VC2M6SP02`) and do not appear.

Coverage and mark map

CD	Subtopic	Questions	Marks
`VC2M5SP01`	6A Objects and their nets	Q1	5
`VC2M5SP02`	6B Grid coordinate systems: describing position and movement	Q2	5
`VC2M5SP03`	6C Translations, reflections, rotations and symmetry	Q3	5
	Total		**15**

The §7 marking rule of 5 marks per subtopic is met exactly. Multiple choice is used sparingly, per §7: 1 mark of 15, Q1(a), four options A–D, where selection — matching a solid to the faces of its net — is genuinely the skill being tested. Q1(c) is the one net item that uses scissors, as the §7 equipment line states.

Answer key

Q	Part	Answer	Marks
1	(a)	B (3 rectangles and 2 triangles)	1
1	(b)	i. Square-based pyramid · ii. 5 faces	2
1	(c)	Prediction with a reason; fold test and outcome stated	2
2	(a)	Coordinate grid constructed to the checklist	2
2	(b)	(5, 2)	1
2	(c)	i. (5, 3) · ii. 4 left and 2 up (in either order)	2
3	(a)	Translation, reflection, rotation	1
3	(b)	Image drawn; corners (6, 1), (4, 1) and (6, 3)	2
3	(c)	The shape (or the size)	1
3	(d)	4	1

Worked solutions

Q1. (a) A triangular prism has 5 faces: a strip of 3 rectangles that wraps around the sides, and 2 identical triangle bases that close the two open ends. Its net is therefore **3 rectangles and 2 triangles** — the answer is **B**. Option C (4 triangles and 1 square) is the net of a square-based pyramid, and options A and D have the wrong shapes and counts.

(b)

i. One square base with a triangle on each of its 4 sides: when the triangles fold up, their points all meet at the one point at the top. The solid is a **square-based pyramid**. ii. Count the faces in the net: 1 square + 4 triangles = **5 faces**.

Marks: 1 for naming the square-based pyramid; 1 for the count of 5 faces.

(c) A correct prediction uses the checks from 6A: the shape must have exactly 6 square faces (the cube has 6 faces), and when the fold is pictured in the head, no two squares may land in the same place and no face may stay open. Sample valid nets: the cross of 6 squares, or a strip of 4 squares with one square above the second square and one square below the third square. Cutting out and folding confirms the prediction.

Marks: 1 for a clearly stated prediction with a reason based on the face count or the fold (the reason must support a shape that genuinely folds into a cube for the mark); 1 for cutting the shape out, folding it and stating whether the fold matched the prediction. A student who chooses a shape that does not fold — for example 6 squares in two rows of three, where two squares fold onto the same face and one face stays open — earns the second mark for an honest test and outcome, but the first mark only if the prediction was "will not fold" with a correct reason.

Q2. (a) A correctly constructed grid has: a horizontal number line 0–6 and a vertical number line 0–6 starting at the same 0 and meeting at a right angle; a light line through every whole number on both axes; and the origin marked and labelled (0, 0) where the axes meet. The numbers sit on the **lines**, not on the spaces — that is what separates a coordinate grid from the Level 4 grid reference system (`VC2M4SP03`).

Marks: 1 for the two axes (same 0, right angle, numbered from 0); 1 for the light lines through each whole number and the origin labelled (0, 0).

(b) The first number tells how far to go along the horizontal axis, and the second number tells how far to go up the vertical axis: 5 along and 2 up is **(5, 2)** — horizontal number first, inside brackets with a comma.

Marks: 1 for both numbers in the correct order. The brackets and comma are the convention taught in 6B and should be present; reversed order (2, 5) names a different point and earns no mark.

(c)

i. Start (1, 5). Moving 4 right makes the first number go up: 1 + 4 = 5, giving (5, 5). Moving 2 down makes the second number go down: 5 − 2 = 3. The robot finishes at **(5, 3)**. ii. To undo 4 right and 2 down, move **4 left and 2 up**, in either order.

Marks: 1 for (5, 3); 1 for 4 left and 2 up. Accept the two moves in either order.

Q3. (a) i. A slide is a **translation**. ii. A flip is a **reflection**. iii. A turn is a **rotation**.

Marks: 1 for all three; half-credit at the teacher's discretion for two of three.

(b) Each corner of the triangle lands the same distance away on the other side of the mirror line at 3. (0, 1) is 3 squares from the line, so its image is 3 squares over at (6, 1). (2, 1) is 1 square from the line, so its image is (4, 1). (0, 3) is 3 squares from the line, so its image is (6, 3). Joining the three image points gives a triangle the same shape and the same size as the original, facing the other way. The corners are **(6, 1), (4, 1) and (6, 3)**.

Marks: 1 for the drawn image with each corner the same distance on the other side of the mirror line; 1 for the three correct coordinates.

(c) In all three moves — a slide, a flip and a turn — the image is the **same shape and the same size** as the original. Either "the shape" or "the size" answers the question. What can change is the position and the orientation.

Marks: 1 for the shape or the size.

(d) A square has **4** lines of symmetry: two through the midpoints of opposite sides and two from corner to corner.

Marks: 1 for 4.