Summer
Scheme of learning
Year 6

White Rose MATHS

#MathsEveryoneCan

Summer Block 1

Shape

Small steps

Step 1	Measure and classify angles
Step 2	Calculate angles
Step 3	Vertically opposite angles
Step 4	Angles in a triangle
Step 5	Angles in a triangle – special cases
Step 6	Angles in a triangle – missing angles
Step 7	Angles in a quadrilateral
Step 8	Angles in polygons

Small steps

Step 9	Circles
Step 10	Draw shapes accurately
Step 11	Nets of 3-D shapes

Measure and classify angles

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Notes and guidance

In Year 4, children encountered the classifications of angles as acute, right and obtuse. In Year 5, this learning was extended to include the use of degrees, as well as reflex angles. This small step revisits that learning by classifying angles and measuring them with a protractor.

Begin by recapping the types of angles. Move on to using a protractor to measure an angle, taking care when modelling which scale to use. Encourage children to estimate the size of an angle before measuring it, as they are then less likely to read the wrong scale on the protractor. For example, if an angle is seen to be less than a right angle, its size will be less than 90°. Children should practise estimating angles by comparing them to known fractions of a turn.

Similarly, classifying angles first can support children in reading the correct scale. For example, if an angle is acute, then the size of the angle in degrees must be less than 90

Things to look out for

- Children may read the scale on the protractor from the wrong end.
- Children may require support when measuring reflex angles with a 180° protractor.

Key questions

- What are the four types of angles?
- How many degrees are there in a right angle?
- How can you describe an acute/obtuse/reflex angle?
- How can you use a protractor to measure an angle? Where on the angle do you place the protractor?
- Does it matter which end of the protractor you start from?
- How can you use a protractor to measure a reflex angle?

Possible sentence stems

- The angle is ______ than ______ of a turn.
  It is a/an ______ angle.
- A/an ______ angle is between ______ and ______ degrees.

National Curriculum links

- Recognise angles where they meet at a point, are on a straight line, or are vertically opposite, and find missing angles
- Draw given angles, and measure them in degrees (°) (Y5)
- Know angles are measured in degrees: estimate and compare acute, obtuse and reflex angles (Y5)

Measure and classify angles

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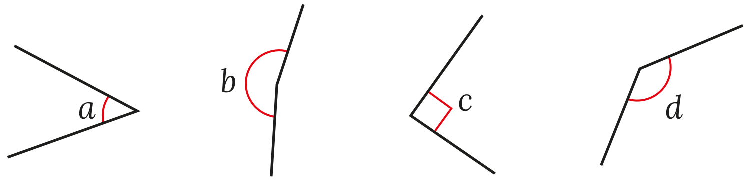
Key learning

- For each angle, choose a word to complete the sentence.

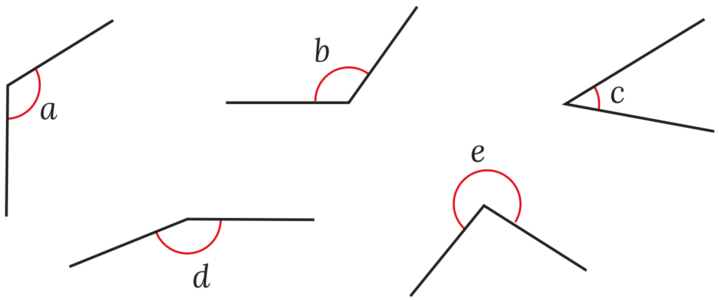


acute | right | obtuse | reflex

Angle ______ is a/an ______ angle.

Order the angles from smallest to greatest.

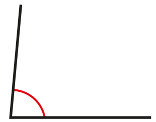
- Use a protractor to measure each angle, then complete the sentences.



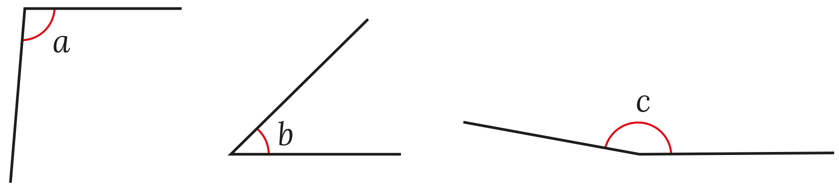
Angle ______ is ______ degrees.

It is a/an ______ angle.

- Nijah knows that this angle is slightly smaller than a right angle, so she estimates that it is approximately 85°.



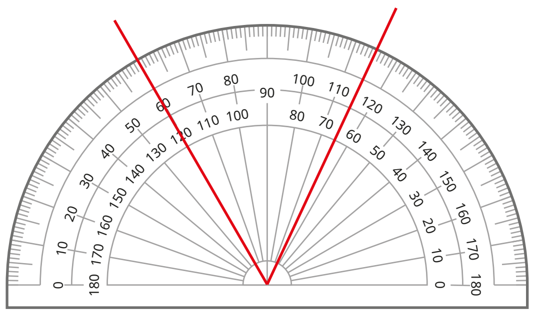
Estimate the sizes of these angles.



Now measure them with a protractor.

How close were your estimates?

- What is the size of this angle?



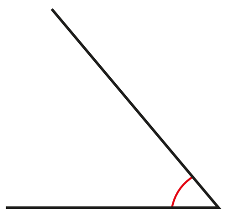
How did you work out your answer?

How else could you measure the angle?

Measure and classify angles

Reasoning and problem solving

Tiny is measuring angles.



Explain why Tiny must be wrong.

What mistake could Tiny have made?

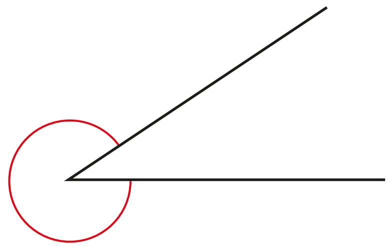
What could the angle measure?

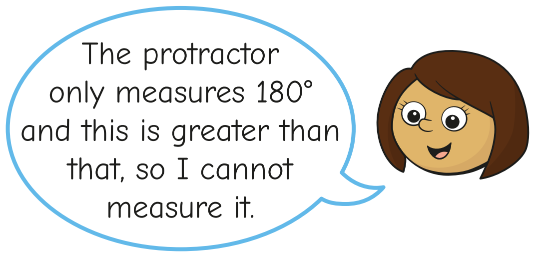
The angle is acute.

Tiny could have used the wrong scale.

50°

Kim is trying to measure the size of this reflex angle.





Do you agree with Kim?

Explain your answer.

No

Calculate angles

Notes and guidance

In Year 5, children learnt that angles on a straight line add up to 180° and angles around a point add up to 360°. That learning is revisited in this small step, with children calculating missing angles from given information.

Children also need to know the symbol for a right angle, and that an angle marked with this symbol measures 90°. They should recognise that without this symbol the size of the angle cannot be assumed.

Children start by calculating missing angles within a right angle, using mental or written strategies to subtract the given angle(s) from 90°. They then revisit angles on a straight line and angles around a point. Children should explore both methods: subtracting each known part from the whole in turn; and adding the known parts together and subtracting this from the whole.

Things to look out for

- Children may try to find missing angles by measuring with a protractor, rather than working them out using given facts.
- Children may make errors when using mental strategies of subtraction, for example 90 – 75 = 25

Key questions

- How can you calculate angles without using a protractor?
- What sort of angle is shown by a square marker?
- What do angles within a right angle add up to?
- What do angles on a straight line add up to?
- What do angles around a point add up to?
- Which angles are already given?
  How can you use these to calculate the missing angle?
- Is there more than one way to work out the answer?

Possible sentence stems

- Angles in a right angle add up to ______°.
- Angles on a straight line add up to ______°.
- Angles around a point add up to ______°.
- The total of angle ______ and angle ______ is ______°.
  To find angle ______, subtract ______ from ______

National Curriculum links

- Recognise angles where they meet at a point, are on a straight line, or are vertically opposite, and find missing angles

Calculate angles

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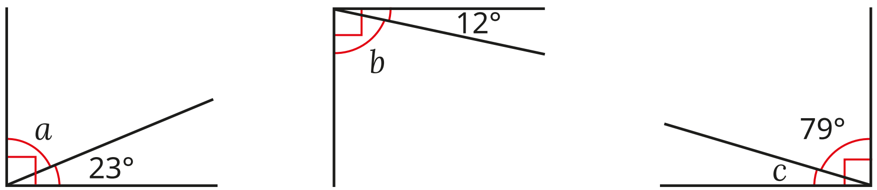
Key learning

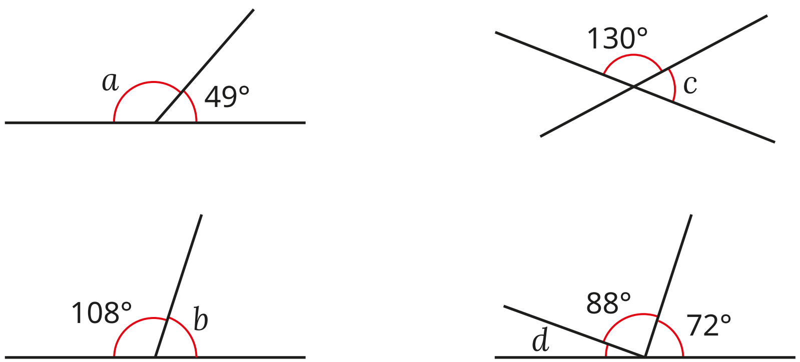
- A right angle measures 90°.

  Use this fact to work out the sizes of angles a, b and c.



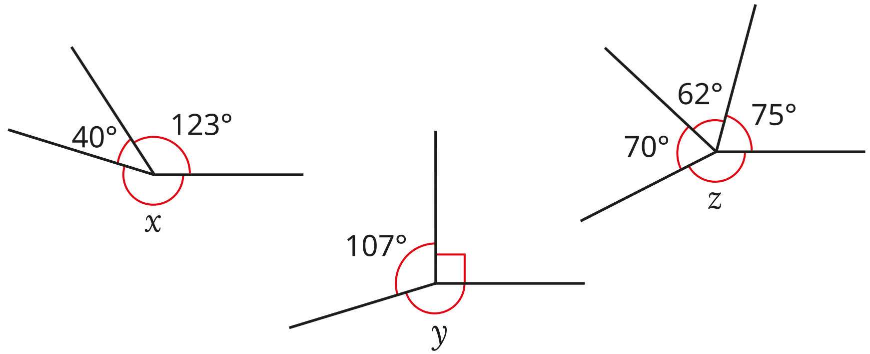
- Angles on a straight line add up to 180°.

  Use this fact to work out the sizes of the angles marked with letters.

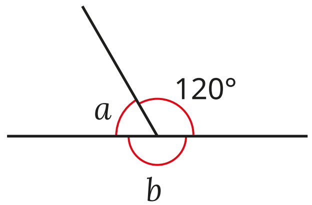


- Angles around a point add up to 360°.

  Use this fact to work out the sizes of the angles marked with letters.



- Here are three angles on a straight line.



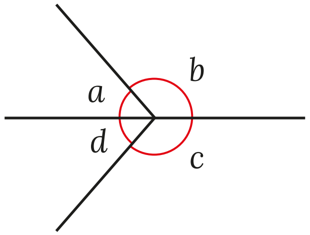
Which of these statements are true?

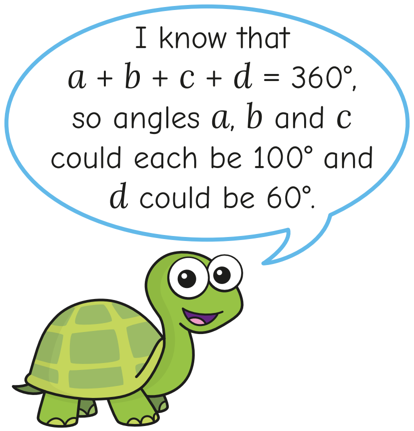
$a < b$	$a + 120° = b$	$b - a = 120°$
a is half the size of 120°.		$a + b = 120°$

Calculate angles

Reasoning and problem solving

Tiny is investigating angles around a point.



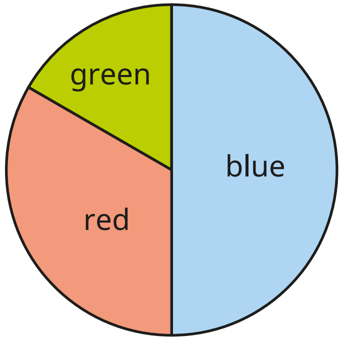


Do you agree with Tiny?

Explain your answer.

No

Here is a pie chart showing the colours of cars sold by a car dealer.



The number of blue cars sold is equal to the total number of red and green cars sold.

The dealer sold twice as many red cars as green cars.

Work out the size of the angle for each sector of the pie chart.

blue: 180°

red: 120°

green: 60°

Vertically opposite angles

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Notes and guidance

In this small step, children learn that vertically opposite angles are equal. Begin by showing what vertically opposite angles are. By drawing two straight lines that intersect at a point, four angles are created. Through investigation, children see that there are two pairs of equal angles. They need to understand that vertically opposite angles are formed when two straight lines cross, and if either of the lines are not straight, then the angles formed are not vertically opposite. Secure this understanding by comparing vertically opposite angles to pairs of angles around a point that are opposite each other, but not vertically opposite, i.e. they are not formed by two straight lines intersecting.

Once children understand that vertically opposite angles are equal, they can use this fact alongside the rules they already know to work out missing angles.

Things to look out for

- Children may think that vertically opposite angles must be vertical in relation to each other, rather than sharing a common vertex.
- Children may think that all opposite angles are equal, rather than only those formed by intersecting straight lines.

Key questions

- What are vertically opposite angles?
- How do you know that the angles are vertically opposite?
- Which angles are the same size? How do you know?
- What number sentences can you write about vertically opposite angles?
- How can you find the size of the missing angle? Is there more than one way?
- What is the difference between vertically opposite angles and two angles around a point that are opposite each other?

Possible sentence stems

- Vertically opposite angles are ______
- If angle ______ is ______°, then angle ______ is also ______°.
- Angles ______ and ______ are equal, because …

National Curriculum links

- Recognise angles where they meet at a point, are on a straight line, or are vertically opposite, and find missing angles

Vertically opposite angles

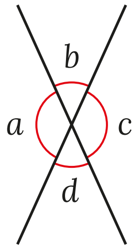
White Rose MATHS

Key learning

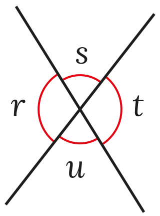
- Take a piece of paper and draw a large "X".
  - Mark the angles on as shown.
  - Measure each angle.
  - What do you notice about angles b and d?

    What do you notice about angles a and c?

    Is this always the case? Draw other "X" shapes to investigate.



- Use the letters from the diagram to complete the statements.



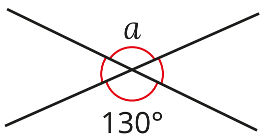
______ = ______

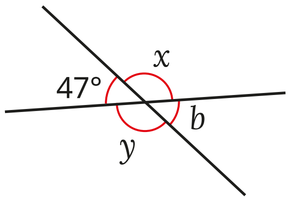
______ + ______ = 180°

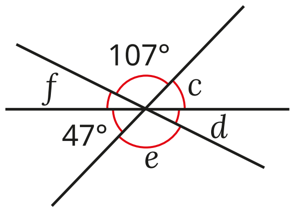
______ = ______

______ + ______ = 180°

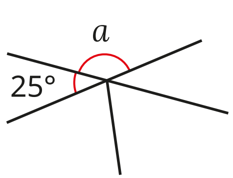
- Work out the sizes of the angles marked with letters.

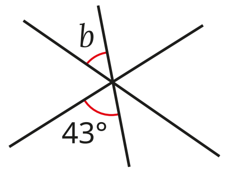


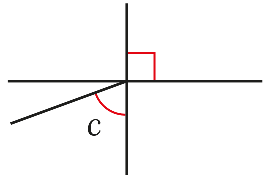




- Each diagram has been drawn using three straight lines.





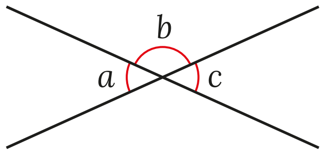


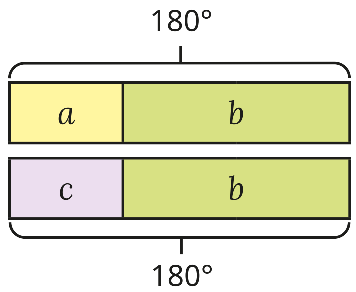
Which of the angle(s) marked with letters can you work out?

Which angle(s) can you not work out?

Talk about it with a partner.

- Brett has drawn a bar model to show the sizes of the angles.



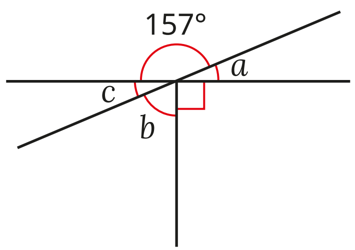


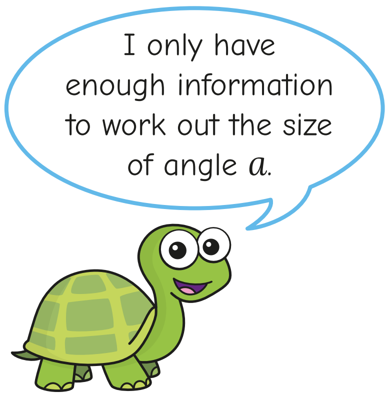
Explain how Brett's bar model shows that angles a and c are the same size.

Vertically opposite angles

Reasoning and problem solving

This diagram is drawn using three straight lines.





Do you agree with Tiny?

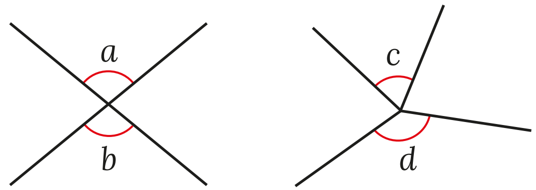
Explain your answer.

No

a = 23°

b = 67°

c = 23°



Are the statements true or false?

Angles a and b are equal.

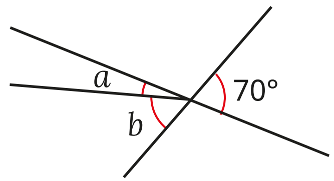
Angles c and d are equal.

Explain your answer.

True

False

Three straight lines are drawn.



b is two and a half times greater than a.

Work out the size of angle a.

a = 20°

Angles in a triangle

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Notes and guidance

In this small step, children learn that the interior angles of a triangle always sum to 180°.

Get children to measure each angle of a triangle and add them together, doing this for a number of different triangles, in order to discover the rule. Discuss that, when using a protractor, there is the possibility of small inaccuracies causing the total to be slightly different from 180°.

When the rule is established, children work out unknown angles in triangles. They should see each angle as a "part" and 180° as the "whole". The three parts add to make the whole. This means that they can work out one of the missing parts by subtracting each of the known parts from the whole, or adding the known parts together before subtracting this from the whole. This step is a good opportunity to revisit mental and written calculation methods, as well as using inverse operations to check answers.

Things to look out for

- Children may try to use a protractor to measure missing angles, rather than working them out based on given facts.
- Children may use 360° (from angles around a point) instead of 180°.

Key questions

- What does "interior" mean?
- How many interior angles does a triangle have?
- How can you measure the angles in a triangle?
- What do the interior angles of a triangle sum to?
- If you know the size of two interior angles in a triangle, how can you work out the third angle?
- Could you work out the missing angle a different way?

Possible sentence stems

- The angles in a ______ add up to ______°.
- The whole (180°) subtract the parts ______° and ______° gives the missing angle, ______°.

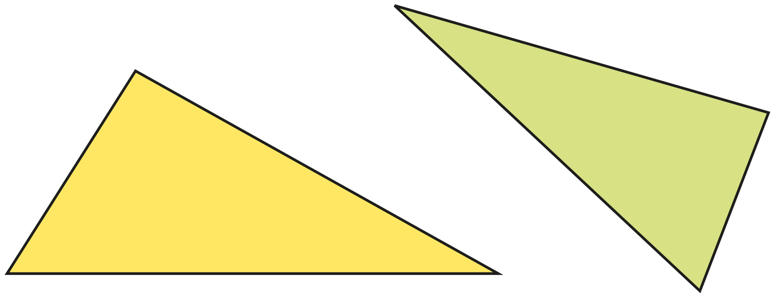
National Curriculum links

- Compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons

Angles in a triangle

Key learning

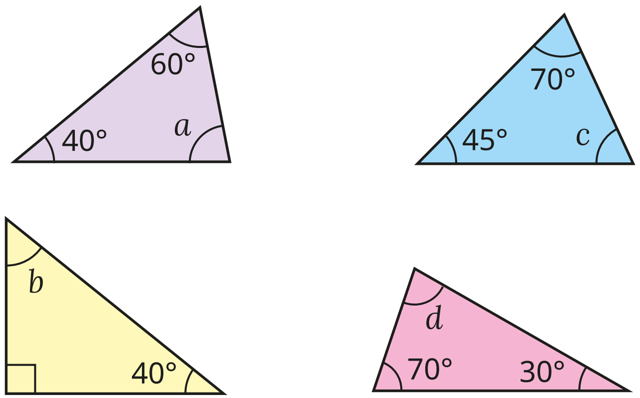
- Use a protractor to measure the angles in each triangle.



  What is the sum of the angles in each triangle?

  What do you notice?

- Calculate the sizes of the angles marked with letters.



- Two angles in a triangle are 75° and 28°.

  What is the size of the third angle?

- One angle in a right-angled triangle is 12°.

  Find the sizes of the other two angles.

- Two angles in a triangle are 36.7° and 15.9°.

  What is the size of the third angle?

- The first angle in a triangle is 42°.

  The second angle is twice the size of the first angle.

  What is the size of the third angle?

- A triangle has angles a, b and c.

  Angle a is twice the size of angle b.

  Angle b is three times the size of angle c.

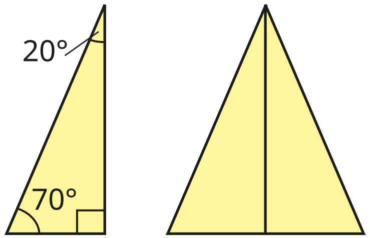
  What is the size of angle c?

Angles in a triangle

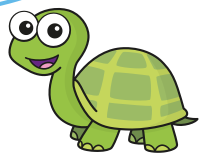
White Rose MATHS

Reasoning and problem solving

An isosceles triangle is made by combining two right-angled triangles.



> The sum of the angles in the right-angled triangle is 180°, so the sum of the angles in the isosceles triangle must be 360°.



Do you agree with Tiny?

Explain your answer.

No

Are the statements true or false?

- A triangle can have three acute angles.
- A triangle can have two right angles.
- A triangle must have at least one obtuse angle.
- All three angles can be the same in a triangle.
- If one of the angles in a triangle is a right angle, the other two angles must be the same as each other.

Explain your answers.

True

False

False

True

False

Angles in a triangle – special cases

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Notes and guidance

In Year 4, children learnt to classify triangles as equilateral, isosceles or scalene, based on the lengths of their sides. They also know that a right-angled triangle has one angle of 90°. In this small step, children extend this learning to include the angles of triangles. Using their knowledge of angles in specific triangles, as well as the total of the angles, children work out missing angles in different types of triangles.

Starting with equilateral triangles, as all the angles are equal, children learn that each angle must be 180° ÷ 3 = 60°. They then move on to investigating isosceles triangles. Children learn that not only do isosceles triangles have two equal sides, but they also have two equal angles. They need to identify which two angles are equal in order to find the sizes of unknown angles in the triangles.

Children may need reminding of hatch mark notation to show that sides of shapes are equal in length.

Things to look out for

- Children may use a protractor to measure unknown angles, rather than working them out from given facts.
- Children may wrongly identify which two angles are equal to each other in an isosceles triangle.

Key questions

- What do the interior angles in a triangle add up to?
- If a triangle is equilateral, what do you know about its sides/angles? How can you work out the size of one of the angles?
- What are the properties of an isosceles triangle?
- Which of the angles in the triangle are equal? How do you know?
- If you know one angle in an isosceles triangle, how can you calculate the sizes of the other two angles?

Possible sentence stems

- In an equilateral triangle, all three angles are ______°.
- In an isosceles triangle, two ______ are equal and two ______ are equal.
- In a right-angled triangle, one of the angles is ______°.

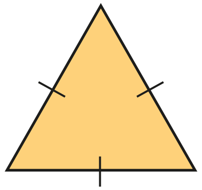
National Curriculum links

- Compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons

Angles in a triangle – special cases

Key learning

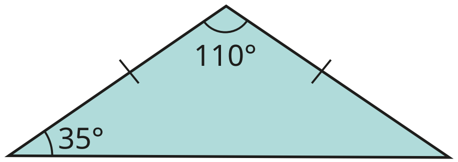
- In an equilateral triangle, all three angles are equal.



What is the size of each angle in an equilateral triangle?

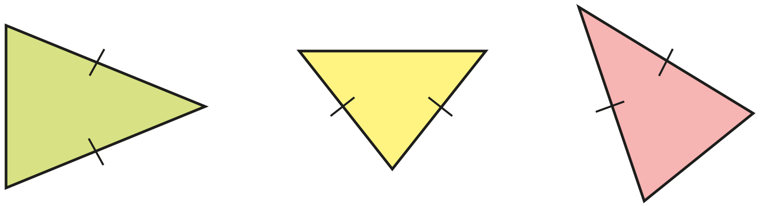
How do you know?

- Work out the missing angle in the isosceles triangle.

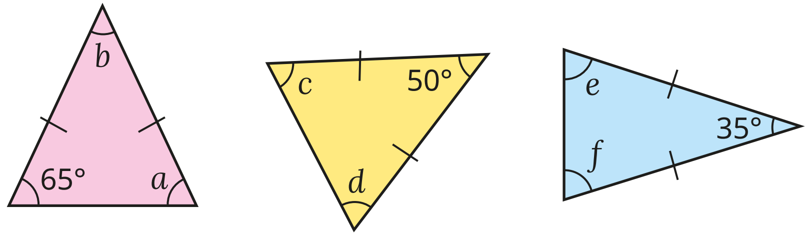


What do you notice?

- Identify which angles will be equal in each isosceles triangle.



- Here are three isosceles triangles.



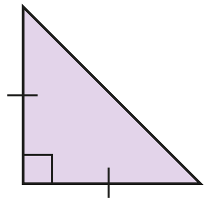
Work out the angles marked with letters.

- One of the angles in an isosceles triangle is 24°.

What could the other two angles be?

Find more than one possible answer.

- A right-angled triangle is also isosceles.



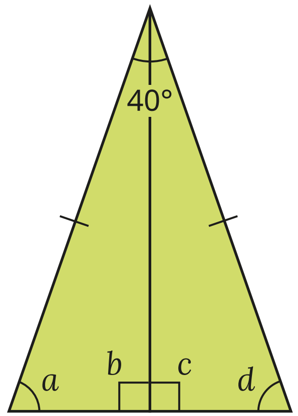
Work out the sizes of all three angles in the triangle.

Angles in a triangle – special cases

Reasoning and problem solving

How many sentences can you write to express the relationships between the angles in the triangles?

One has been done for you.



$40° + a + d = 180°$

multiple possible answers, e.g.

$20° + a + b = 180°$

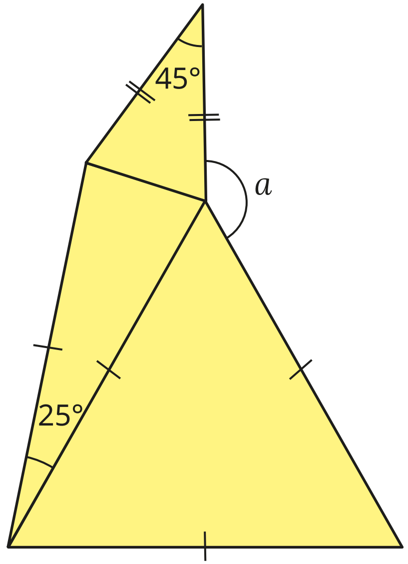
$20° + c + d = 180°$

$b = 90°$, $c = 90°$

$b = c$

$a = d$

The shape is made from two isosceles triangles and an equilateral triangle.



Work out the size of angle a.

$a = 155°$

Angles in a triangle – missing angles

Notes and guidance

In this small step, children combine what they have learnt so far in this block to solve a variety of missing angle questions. By thinking about angles in different types of triangles, as well as in right angles, on a straight line and around a point, children should be able to work out the sizes of missing angles in increasingly complex problems.

Begin by recapping the rules of angles they have learnt so far, and then share a problem with the class and discuss what methods are available based on the facts they know. Work through missing angle problems that begin with one focus, but move on to examples that require knowledge of more than one rule. At each stage, ask children to explain what rules they have used to solve the problem. They will find that there are multiple ways of solving most problems, and this will consolidate their understanding of the rules.

Things to look out for

- Children may measure missing angles with a protractor, rather than working them out based on given facts.
- Children may need support to work out intermediate angles when the required angle cannot be found in one step.

Key questions

- Why can you not always find the size of the missing angle by measuring?
- What type of triangle is this? How will knowing that help you to find the value of the missing angle?
- Do you need to work out a different angle before you can work out the missing angle?
- Which angles can you work out straight away? How will that help you to work out other angles?
- What do angles in a right angle/on a straight line/around a point add up to?

Possible sentence stems

- The sum of angles in a triangle is ______°.
- The sum of angles on a straight line is ______°.
- The sum of angles around a point is ______°.
- Vertically opposite angles are ______

National Curriculum links

- Compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons

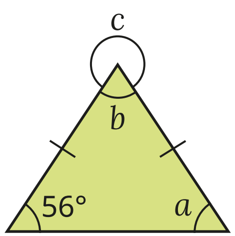
Angles in a triangle – missing angles

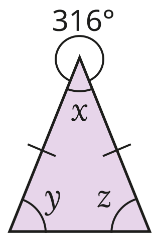
White Rose MATHS

Key learning

- Work out the sizes of the angles marked with letters.

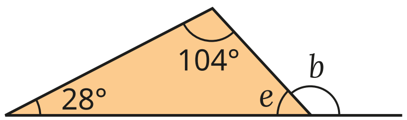
  Explain each step in your workings.

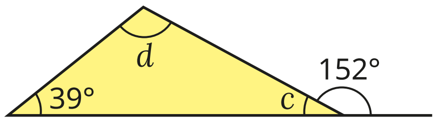




- Work out the sizes of the angles marked with letters.

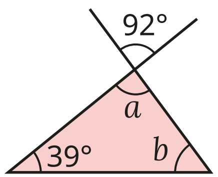
  Explain each step in your workings.

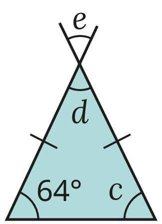




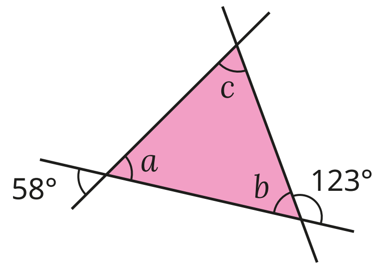
- Work out the sizes of the angles marked with letters.

  Explain each step in your workings.

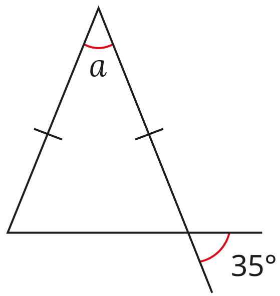


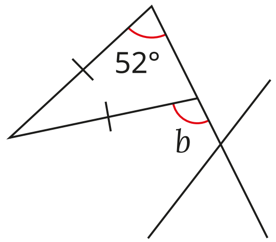


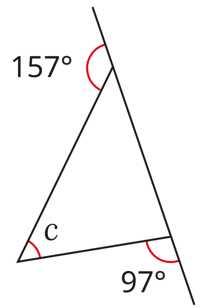
- Work out the sizes of the angles marked with letters.



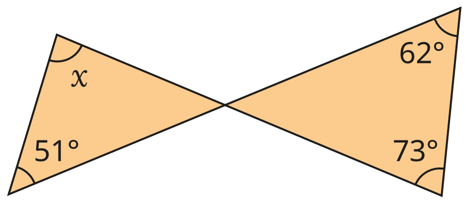
- Discuss with a partner how you could work out each of the angles marked with letters. How many ways can you find to work out each one?





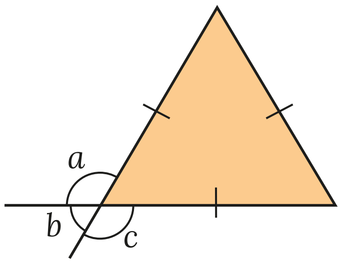


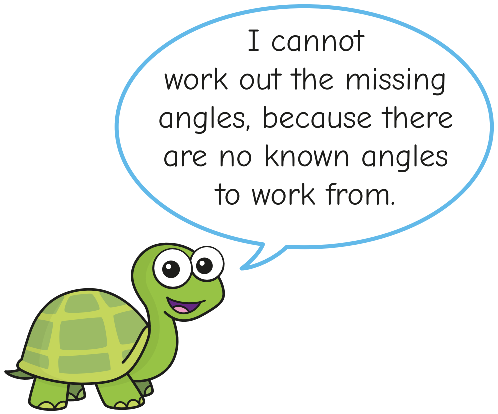
- Work out the size of angle x.



Angles in a triangle – missing angles

Reasoning and problem solving





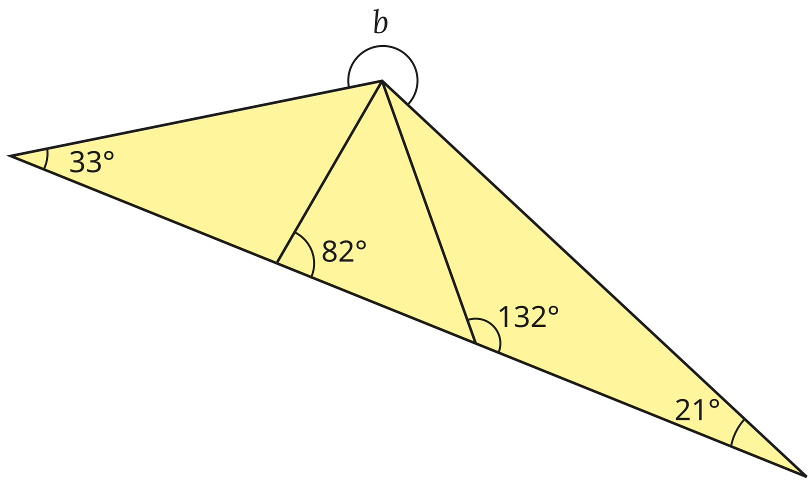
Do you agree with Tiny?

Explain your answer.

The triangle is an equilateral triangle, so each angle is 60°.

Tiny can then use other rules to work out angles a, b and c.

Work out the size of the reflex angle b.



What other angles can you work out?

b = 234°

Angles in a quadrilateral

White Rose MATHS

Notes and guidance

In Year 4, children explored the properties of different quadrilaterals and they should be familiar with the words “trapezium”, “rhombus”, “square”, “rectangle”, “parallelogram” and “kite”. They learnt about the equal and parallel sides in quadrilaterals, as well as which ones have right angles. In this small step, that learning is extended to include the properties of the angles in these quadrilaterals.

For a square and a rectangle, the fact that the angles add up to 360° can be worked out quickly. For other quadrilaterals, children can investigate by measuring the angles with a protractor. Show that, as any quadrilateral can be split into two triangles, the sum of the interior angles is twice that of a triangle and compare this with the totals found by measuring.

Children then move on to explore the relationships between angles in a rhombus and a parallelogram, where opposite angles are equal.

Things to look out for

- Children may incorrectly identify equal sides and/or angles.
- Children may try to use 180° instead of 360° as the sum of the angles in a quadrilateral.

Key questions

- What is a quadrilateral?
- In what ways can quadrilaterals be different from one another?
- What is the sum of the interior angles in a quadrilateral?
- What is the same/different about a rhombus and a square?
- If you know one angle in a parallelogram, how can you work out the sizes of the missing angles?

Possible sentence stems

- The sum of interior angles in any quadrilateral is ______°.
- A parallelogram has two pairs of equal ______ and two pairs of equal ______
- A rhombus has two pairs of equal ______ and two pairs of equal ______

National Curriculum links

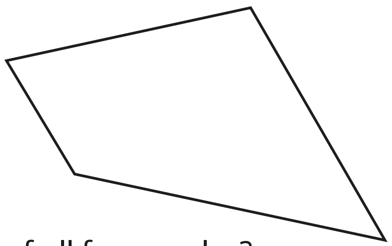
- Compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons

Angles in a quadrilateral

White Rose MATHS

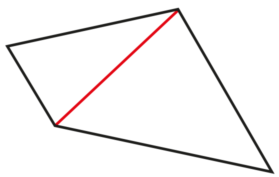
Key learning

- Measure the angles of the quadrilateral.



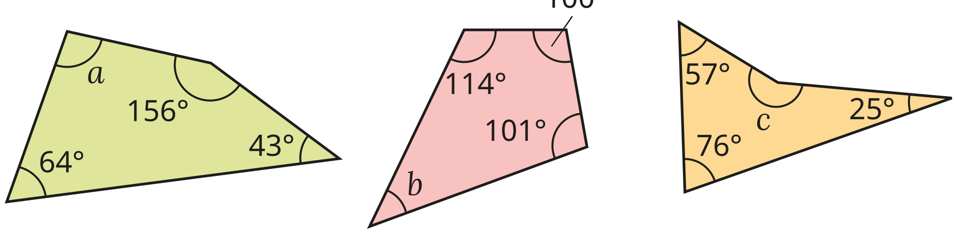
What is the sum of all four angles?

Huan draws a line on the quadrilateral to prove that the angles in any quadrilateral add up to 360°.

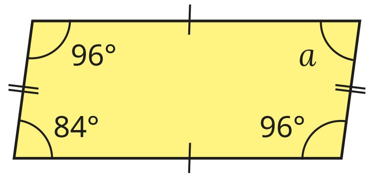


Explain Huan's reasoning.

- Work out the missing angles in the quadrilaterals.

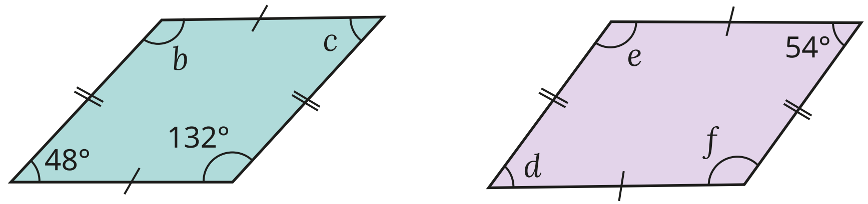


- Work out the size of angle a in the parallelogram.

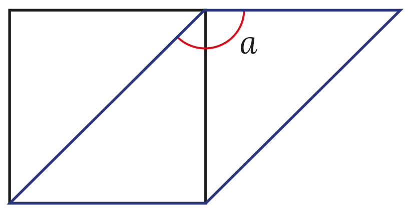


What do you notice about the opposite angles in a parallelogram?

Use this to work out the angles marked with letters in the parallelograms.



- A parallelogram has been drawn over the top of a square.

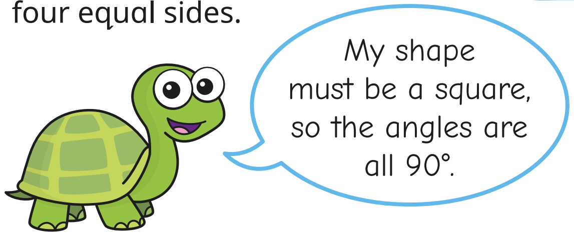


Work out the size of angle a.

Angles in a quadrilateral

Reasoning and problem solving

Tiny draws a quadrilateral with four equal sides.



Do you agree with Tiny?

Explain your answer.

No

Esther draws a quadrilateral with exactly two right angles.

What types of quadrilaterals could she have drawn?

Is it possible to draw a quadrilateral with exactly three right angles?

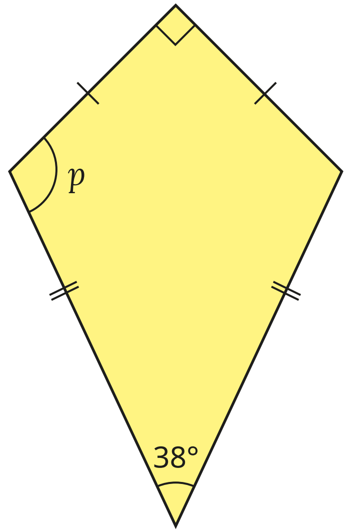
Explain your answer.

trapezium or kite

No

3 right angles sum to 270°, so the 4th angle must be 360 ° – 270° = 90°.

Here is a kite.



Work out the size of angle p.

Talk to a partner about how you worked it out.

p = 116°

Angles in polygons

White Rose MATHS

Notes and guidance

In this small step, children develop their understanding of interior angles in 2-D shapes by looking at polygons with five or more sides.

Building on the fact that a quadrilateral can be split into two triangles, so the interior angles add up to 180 × 2 = 360°, children explore how many triangles polygons with a greater number of sides can be split into using a vertex of the polygon. They learn that the number of triangles is two fewer than the number of sides. Multiplying the number of triangles by 180° gives the sum of the interior angles in the polygon. Using this information, they can find unknown angles for any polygon. The main focus of this step is on regular polygons, where children can divide the total by the number of sides to work out the size of each angle.

Things to look out for

- Children may use a protractor instead of calculating a missing angle.
- Children may multiply the number of sides by 180° to find the sum of the interior angles.
- When looking for the number of triangles, children may draw too many triangles by drawing lines from more than one vertex of the polygon.

Key questions

- What is a polygon?
- What is the difference between a regular and an irregular polygon?
- How many triangles can you make in this polygon?
- Why is it important to draw the triangles from a single vertex?
- If the sum of interior angles in each triangle adds up to 180°, how can you work out the sum of the interior angles in the polygon?
- If you know the sum of the interior angles in a polygon, how can you use this information to find a missing angle?

Possible sentence stems

- If there are ______ sides, then there are ______ triangles.
- The sum of the angles is ______ × 180° = ______°.
- The sum of the interior angles in a ______ is ______°.

National Curriculum links

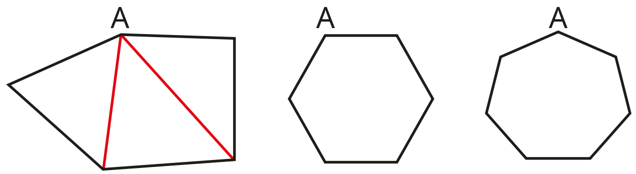
- Compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons

Angles in polygons

Key learning

- Aisha splits a pentagon into three triangles by drawing lines from vertex A.

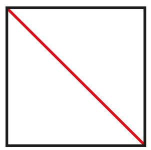
  Use Aisha's method to split the other shapes into triangles.



  What do you notice about the number of sides a shape has and the smallest number of triangles each one can be split into?

- Scott can make two triangles from a quadrilateral.

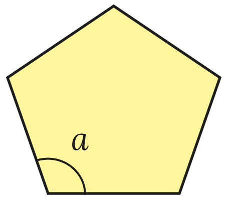
  He then knows that the sum of the interior angles in a quadrilateral must be 360°.



  Use Scott's method to complete the table.

Shape	Number of sides	Number of triangles	180 × number of triangles	Sum of interior angles
square	4	2	180 × 2	360°
pentagon	5	3		
hexagon				
heptagon				
octagon				

- Here is a regular pentagon.

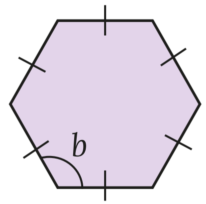


  - What is the sum of the interior angles of a pentagon?

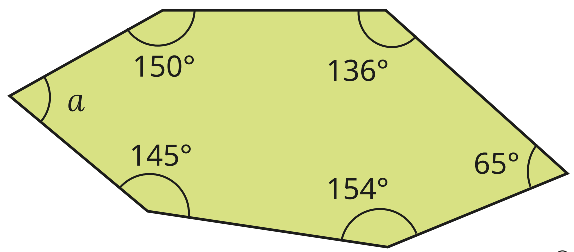
    How do you know?
  - What is the size of angle a?

    How do you know?

- Calculate the size of the angle b.



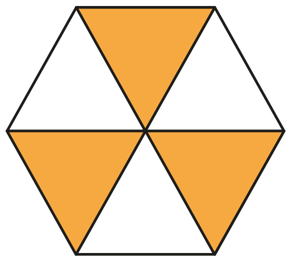
- Work out the size of angle a.

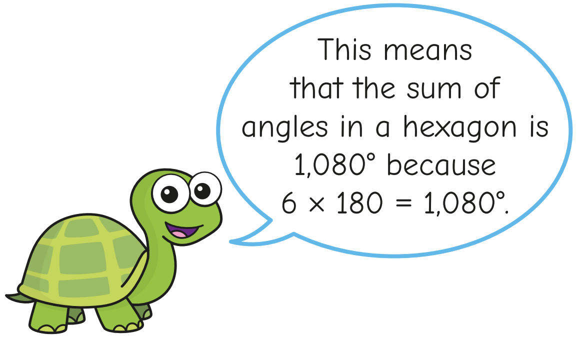


Angles in polygons

Reasoning and problem solving

Tiny draws six triangles inside a hexagon.





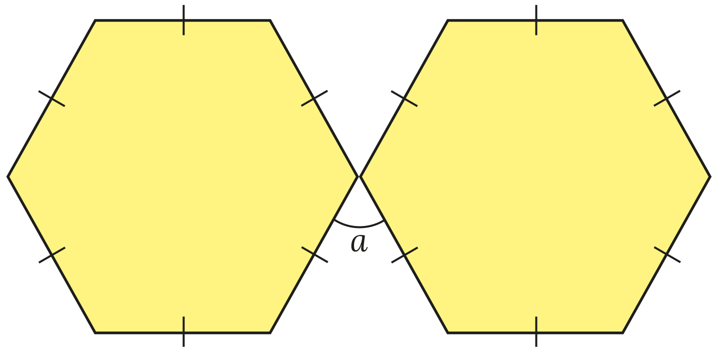
Do you agree with Tiny?

Explain your answer.

No

Tiny's total includes the angles at the centre of the hexagon, not just those at the vertices.

Here are two regular hexagons.



Work out the size of angle a.

a = 60°

Circles

Notes and guidance

Children used circles in pie charts in the Statistics block in the Spring term. In this small step, they develop their learning to ensure understanding of the words “radius”, “diameter” and “circumference”.

Children need to understand the importance of the centre of a circle: it is the point that is an equal distance from every part of the edge of the circle. They then move on to looking at the connection between the radius and the diameter. It is important that they realise that both of these are related to the centre. Showing examples and non-examples of radii and diameters will help to reinforce this understanding.

At this stage, children do not need to be able to calculate the circumference. It may be useful to discuss that using a piece of string around the outside of a circle, then measuring it, will give an approximate measure for this.

Things to look out for

- Children may confuse the terms “radius” and “diameter”.
- Children may think that a diameter is any line across a circle, even if it does not go through the centre.

Key questions

- What does the term “radius”/”diameter”/”circumference” mean?
- What is the relationship between the radius and the diameter of a circle?
- What point must the diameter of a circle go through?
- If you know the diameter of a circle, how can you calculate its radius?
- If you know the radius of a circle, how can you calculate its diameter?
- How can you tell if a line across a circle is a diameter or not?

Possible sentence stems

- The radius of a circle is ______ the size of the diameter of the circle.
- The diameter of a circle is ______ the size of the radius of the circle.
- All the points on the circumference of a circle are an ______ distance from the ______

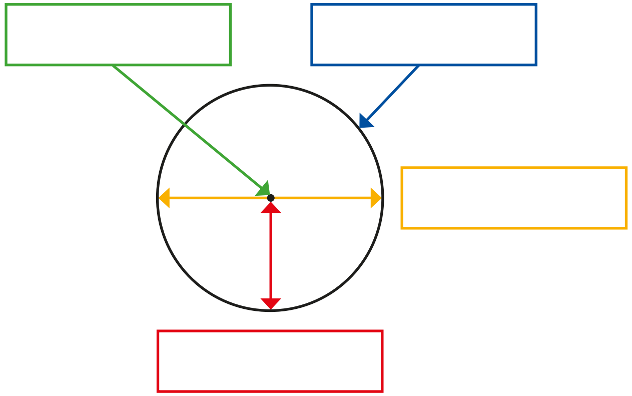
National Curriculum links

- Illustrate and name parts of circles, including radius, diameter and circumference and know that the diameter is twice the radius

Circles

Key learning

- Use the labels to complete the diagram.



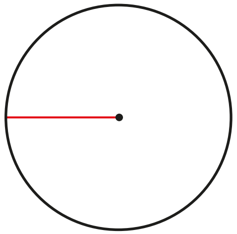
radius

diameter

centre

circumference

- Filip has drawn a 5 cm straight line from the centre of the circle to its edge.

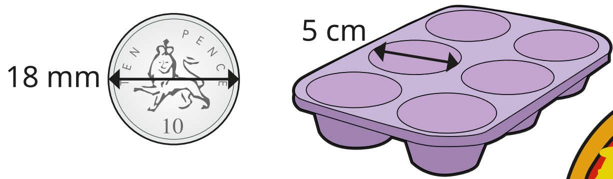


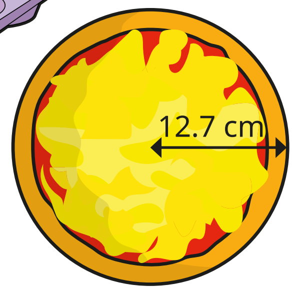
  - What is the name of the line Filip has drawn?
  - Explain to a partner how Filip can use this line to help him find the diameter of the circle.

- Complete the table.

Radius	Diameter
26 cm	
	37 mm
2.55 m	
	99 cm
	19.36 cm

- Find the radius and the diameter for each object.





The radius is _______

The diameter is _______

I know this because …

- If the radius of a circle is r and the diameter is d, which formula shows the relationship between the radius and diameter of the circle?

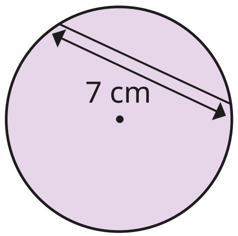
$2r = d$ | $2d = r$ | $r + 2 = d$ | $d + 2 = r$

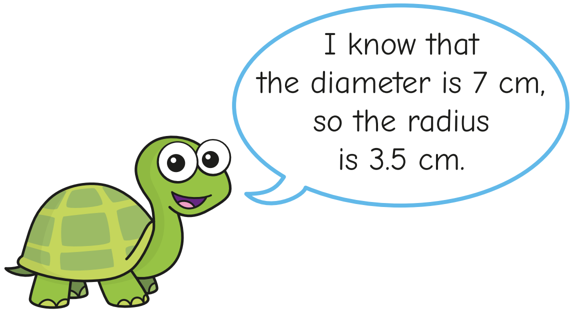
Circles

White Rose MATHS

Reasoning and problem solving

Tiny is trying to find the radius of the circle.





Do you agree with Tiny?

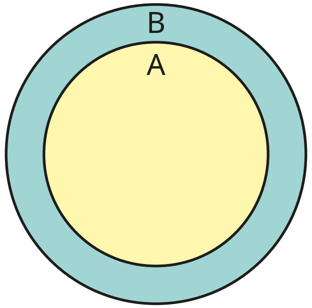
Explain your answer.

No

The diameter needs to pass through the centre of the circle and this line does not.

Circle A has been drawn on top of circle B.

The diameter of circle A is $\frac{3}{4}$ the diameter of circle B.



If the diameter of circle B is 12 cm, what is the diameter of circle A?

If the diameter of circle A is 12 cm, what is the diameter of circle B?

If the radius of circle B is 6 cm, what is the radius of circle A?

If the radius of circle A is 6 cm, what is the diameter of circle B?

9 cm

16 cm

4.5 cm

16 cm

Draw shapes accurately

Notes and guidance

In this small step, children use skills learnt so far in this block to accurately draw shapes when given specific dimensions.

Children begin drawing simple shapes that can be done on squared paper, such as rectangles and right-angled triangles where the base and height are given. This could be extended to drawing shapes where the perimeter and some of the sides are known.

Children then produce an accurate drawing of a shape with known angles. They may need to begin by practising using a protractor. Children should work systematically, starting with a side and then drawing the angle(s) from the correct end(s). They should also use their understanding of the features of different quadrilaterals and triangles to recreate these accurately.

This step is a good opportunity to revisit converting between centimetres and millimetres.

Things to look out for

- Children may need support to decide which part of the shape to draw first.
- Children may start from the wrong end of the scale on a protractor.

Key questions

- How can you use squared paper to draw a shape with right angles?
- What tools can you use to help you draw a shape accurately?
- What do you know about the shape that will help you to draw it accurately?
- Which part of the shape can you draw first? Then what can you draw?
- How can you check if your shape is drawn accurately?
- What labels can you add to your drawing?
- Which scale on the protractor do you need to use?

Possible sentence stems

- If the perimeter of the rectangle is ______ cm and one side is ______ cm, then the other sides must be ______ cm, ______ cm and ______ cm.
- If an angle is ______ than 90°, I need to use the ______ scale on the protractor.

National Curriculum links

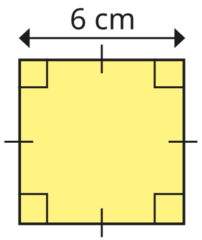
- Draw 2-D shapes using given dimensions and angles

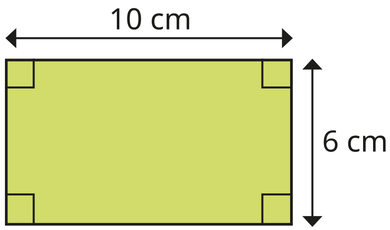
Draw shapes accurately

White Rose MATHS

Key learning

- Draw the shapes accurately on squared paper.

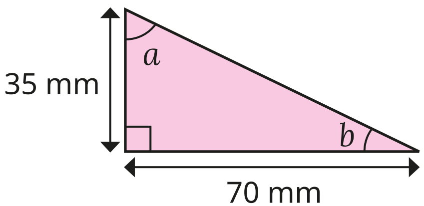




- Draw the right-angled triangle accurately on squared paper.

  What is the missing length?

  Measure the sizes of angles a and b.



- Draw the shapes accurately on squared paper.
  - a square with a perimeter of 16 cm
  - a rectangle with an area of 20 cm^2
  - a right-angled triangle with a height of 8 cm and a base of 6 cm

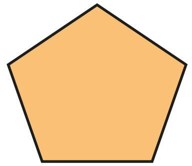
- The sides of a right-angled triangle are 3 cm, 4 cm and 5 cm.

  Draw the triangle and measure the sizes of its angles.

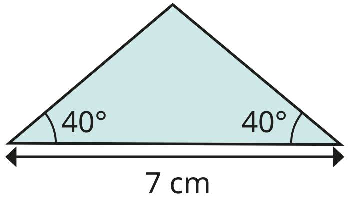
  Label the triangle with as much information as you can.

- What is the size of each interior angle of the regular polygon?

  Accurately draw a regular pentagon with a side length of 5 cm.



- Write a step-by-step plan to draw the triangle.



  Use your plan to make an accurate copy of the triangle.

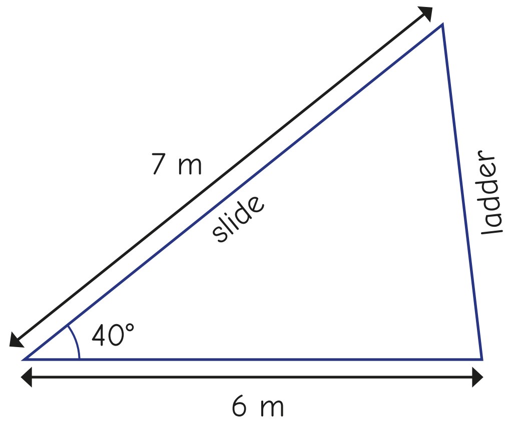
- Use a ruler and a protractor to draw the shapes.

  Label the information that is given to you on the shape, as well as any equal or parallel lines.
  - a right-angled triangle with one angle of 38°
  - a parallelogram with two angles of 40° and two sides of 6 cm
  - an equilateral triangle with a perimeter of 21 cm
  - an irregular pentagon with a perimeter of 75 cm and two interior right angles

Draw shapes accurately

Reasoning and problem solving

Mr Hall is designing a slide for the playground.



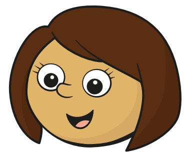
Use a scale of 1 cm to represent 1 m.

Draw a scale diagram.

Use the diagram to find out approximately how long the ladder needs to be.

approximately 4.5 m

Kim has drawn a scalene triangle.



- Angle a is the greatest angle.
- Angle b is 20° larger than angle c.
- Angle c is 70° smaller than angle a.

Use a bar model to help you calculate the size of each angle.

Then draw Kim's triangle.

Is there more than one way to draw the triangle?

a = 100°

b = 50°

c = 30°

These angles work with different side lengths.

Nets of 3-D shapes

Notes and guidance

In the final small step of this block, children learn that they can make a 3-D shape using knowledge of the 2-D shapes that make up its faces.

Children should be familiar with 3-D shapes from earlier years, but you may need to remind them how to describe these shapes using edges, faces, vertices and curved surfaces. They should explore this step practically, starting with nets of a cube, made up of six squares, and investigating which arrangements will and will not fold to make a cube. Children can then move on to looking at other 3-D shapes and what 2-D shapes are needed to make their nets. Again, they first need to explore this with cut-out nets, which will help them to become more adept at visualising how nets fold up. Children can then work from a 3-D shape to decide how the net will look.

Things to look out for

- Children may have the correct number of 2-D shapes in a net, but not in an arrangement that will create the correct shape.
- Children may need a reminder of vocabulary such as "prism" when naming 3-D shapes.

Key questions

- How many faces does a ______ have? What shapes are they?
- What is the difference between a 2-D and a 3-D shape?
- What 2-D shapes are needed to create the net of a ______?
- What 3-D shape will this net create?
- Which two faces of the 3-D shape made from this net will be opposite each other?
- How many different ways can you arrange the faces of the net so that it still folds up to make the ______?

Possible sentence stems

- The net needed to make a ______ will contain ______ ______ and ______ ______ (e.g. triangular prism, three rectangles, two triangles)
- I know that this net will make a ______ because …

National Curriculum links

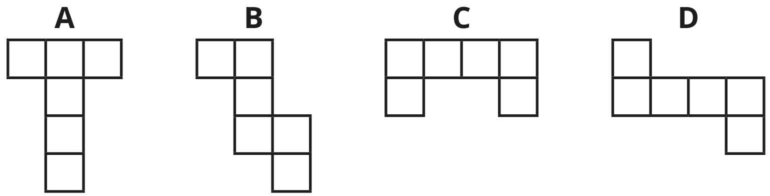
- Recognise, describe and build simple 3-D shapes, including making nets

Nets of 3-D shapes

White Rose MATHS

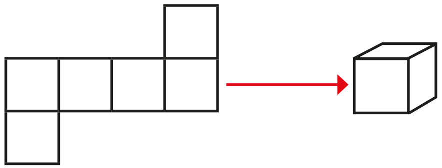
Key learning

- Which nets will fold up to make a cube?

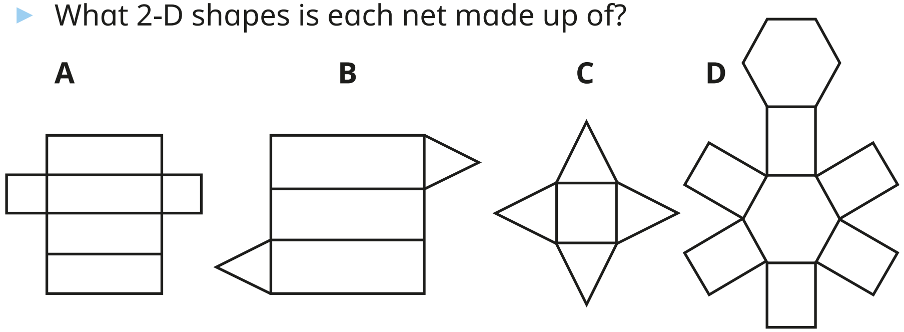


Investigate other possible nets for a cube.

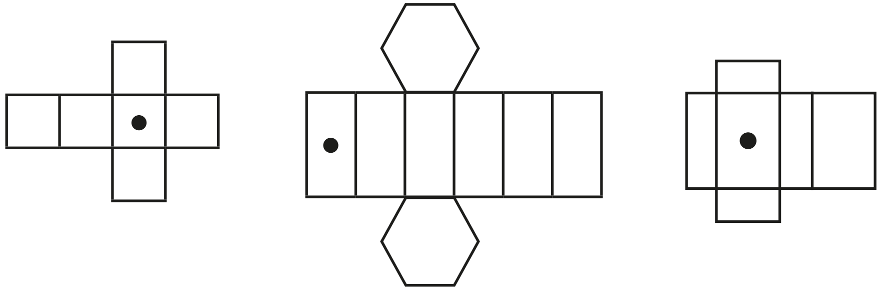
- The net of a cube is made up of six squares.



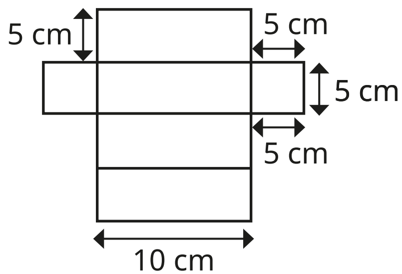
  - Which 3-D shapes will these nets make?
  - What 2-D shapes is each net made up of?



- Draw another dot on each net so that the dots are on opposite faces when the net is folded to make the 3-D shape.



- Draw the net accurately on squared paper.



- Draw nets for the 3-D shapes described.
  - The faces are made up of a square and four triangles.
  - The faces are made up of rectangles and triangles.

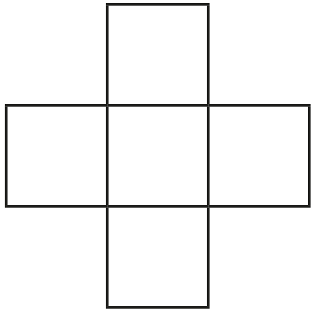
Find as many shapes as you can for each description.

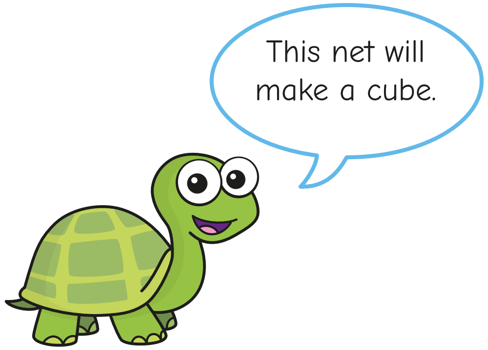
Make the 3-D shapes from your nets.

Nets of 3-D shapes

Reasoning and problem solving

Tiny is making nets.





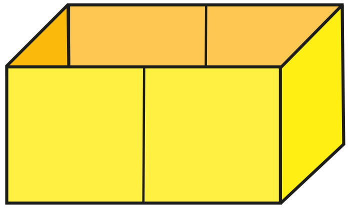
Do you agree with Tiny?

Explain your answer.

No

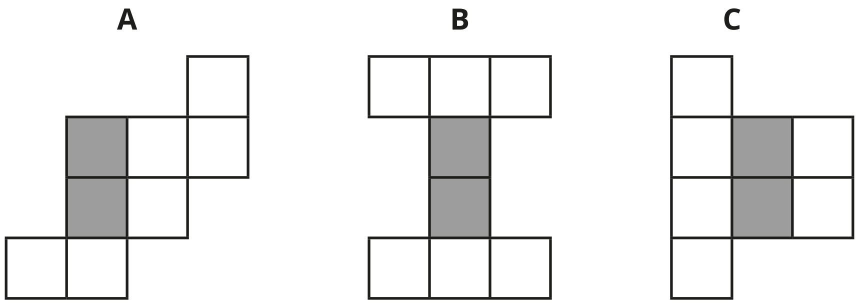
A cube has six faces, but the net only has five.

Here is an open box.



Which nets will fold to make the box?

The grey squares show the base.



B and C

Summer Block 2

Position and direction

White Rose MATHS

Small steps

Step 1	The first quadrant
Step 2	Read and plot points in four quadrants
Step 3	Solve problems with coordinates
Step 4	Translations
Step 5	Reflections

The first quadrant

White Rose MATHS

Notes and guidance

Children were first introduced to a coordinate grid in Year 4. That learning is revisited in this small step, with children looking at the first quadrant, where both the x- and y-coordinates are positive.

Begin by recapping what the coordinate grid is and the names of the two axes, x and y. Then consider points on the grid. Discuss how children can find the coordinates for a given point, reading the first value on the x-axis and the second value on the y-axis. Children then move on to plotting points with given coordinates. Ensure that children understand the importance of the order of the values.

Children draw shapes on a coordinate grid, suggesting possible coordinates for vertices of different shapes. Finally, they solve problems in the first quadrant without the support of grid lines, using given coordinate information to find the coordinates of other points.

Things to look out for

- Children may confuse the x- and y-values of the coordinates and read or plot them in the wrong order.
- Children may think a coordinate refers to a square on the grid rather than a single point.

Key questions

- What is a coordinate grid?
- What is the name of the horizontal/vertical axis?
- What are the coordinates of this point?
- Which axis do you look at first when finding the coordinates of a point?
- Where does the point ______ go on the grid?
- What do you notice about all the points that are on a horizontal/vertical line?
- How can you work out the missing coordinate(s)?

Possible sentence stems

- The first value in a pair of coordinates is for the ______-axis and the second value is for the ______-axis.
- The x-coordinate of the point is ______ and the y-coordinate is ______
  The point is (______, ______).

National Curriculum links

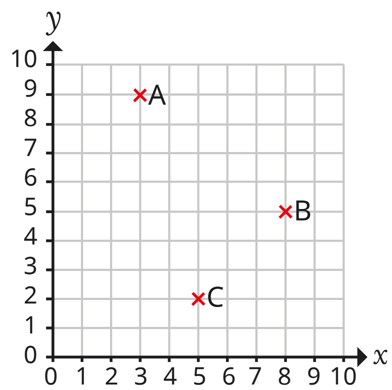
- Describe positions on the full coordinate grid (all four quadrants)

The first quadrant

White Rose MATHS

Key learning

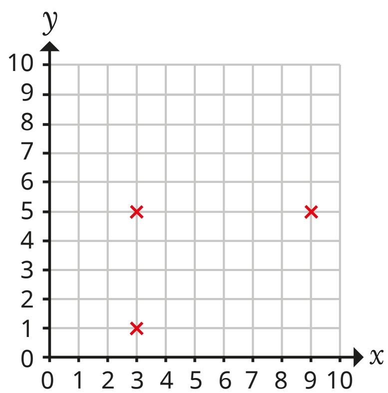
- Here is a coordinate grid.



  - What are the coordinates of the points A, B and C?
  - Plot points D, E and F on the grid.

D (1, 5)   E (5, 5)   F (0, 8)

- Tommy is drawing a rectangle on a coordinate grid.



Find the coordinates of the fourth vertex of the rectangle.

- Plot the points (7, 1), (7, 4) and (10, 1) on a coordinate grid.

  Join the points to form a polygon.

  What polygon have you drawn?

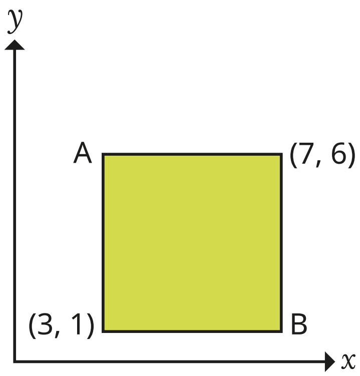
- Plot four points on a coordinate grid to make a square.

  What are the coordinates of the vertices?

  What patterns can you see?

  How do you know that the shape is a square?

- The diagram shows the coordinates of two vertices of a rectangle.



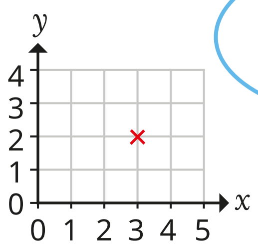
What are the coordinates of the other two vertices?

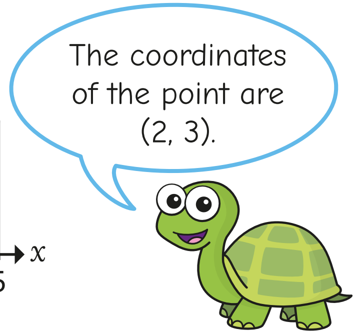
How did you work out the coordinates?

The first quadrant

White Rose MATHS

Reasoning and problem solving



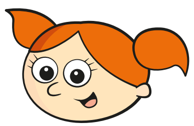


Do you agree with Tiny?

Explain your answer.

No

(2, 2) (3, 3) (7, 7)



Alex thinks that when she joins these points, they will make a straight line.

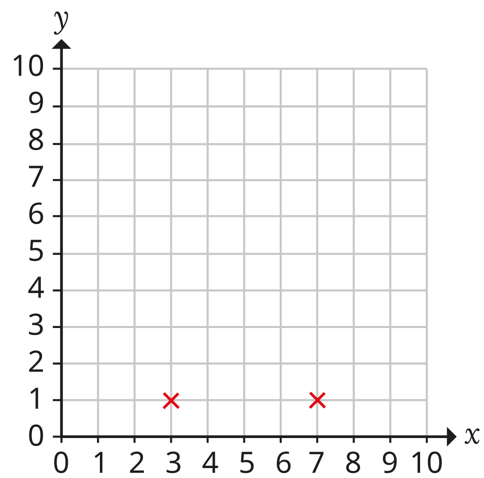
Do you agree with Alex?

Explain your answer.

Yes

Huan wants to draw an isosceles triangle on the coordinate grid.

He has already plotted the points for two of the vertices.



What could the coordinates of the third vertex be?

How many different answers can you find?

(5, a), where a is not equal to 1

(3, 5)

(7, 5)

Read and plot points in four quadrants

White Rose MATHS

Notes and guidance

In this small step, children extend their understanding of the coordinate grid to include all four quadrants. It may be helpful to refer to these as the first (top-right), second (top-left), third (bottom-left) and fourth (bottom-right) quadrants.

Show children that the x- and y-axes can both be extended through zero into negative numbers. Children plot points in each of the "new" quadrants in turn. Model that the process is the same as for the first quadrant, and emphasise that the axes behave in the same way as number lines with positive and negative numbers, which children are already familiar with. Children should recognise the pattern of positive and negative coordinates that belong in each quadrant.

When children are comfortable with points in each of the quadrants, they move on to drawing shapes in the coordinate grid, using all of the quadrants. Finally, they determine which quadrant a point with given coordinates is in, without the use of a grid to support them.

Things to look out for

- Children may confuse the x- and y-values of the coordinates and read or plot them in the wrong order.
- Children may ignore or omit the negative sign.

Key questions

- Which axis do you look at first when finding the coordinates of a point?
- What are the coordinates of the point?
- What are the coordinates of the vertices of the shape?
- Where does the point ______ go on the grid?
- How do you know if the x-value/y-value is positive or negative?
- What do you notice about the coordinates in the first/second/third/fourth quadrant?

Possible sentence stems

- The first value in a pair of coordinates is for the ______-axis and the second value is for the ______-axis.
- The x-coordinate of the point is ______ and the y-coordinate is ______. The point is (______, ______).
- The x-coordinate of a point in the ______ quadrant is ______
- The y-coordinate of a point in the ______ quadrant is ______

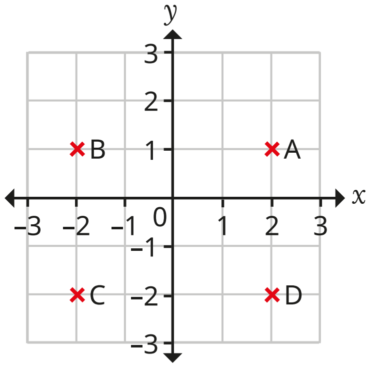
National Curriculum links

- Describe positions on the full coordinate grid (all four quadrants)

Read and plot points in four quadrants

Key learning

- What are the coordinates of the four points?



How did you work them out?

Compare answers with a partner.

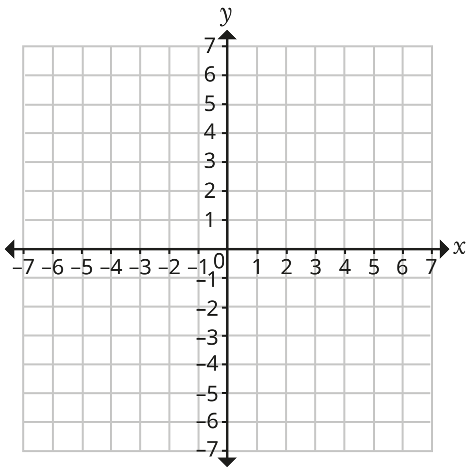
- Plot and label the points on the grid.

D (4, 5)

E (–3, 2)

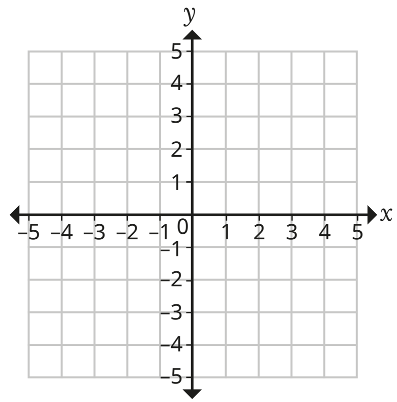
F (6, –5)

G (–1, –7)



- Draw a polygon with vertices at (–2, 2), (–4, 2), (–4, –2) and (–2, –3).

  What is the mathematical name of the shape?

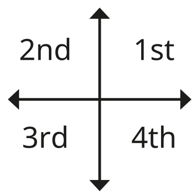


- Draw a coordinate grid with each axis from –5 to 5

  Draw a square with a vertex in each quadrant.

  Write the coordinates of the vertices.

- Write the coordinates of four points, one in each quadrant.



- Without plotting points P, Q, R and S, describe which quadrant each point is in.

P (–8, 3)

Q (8, –3)

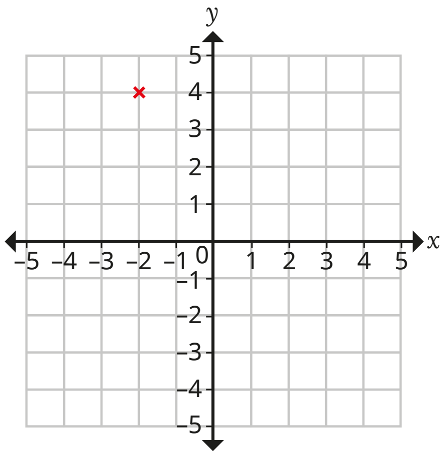
R (8, 3)

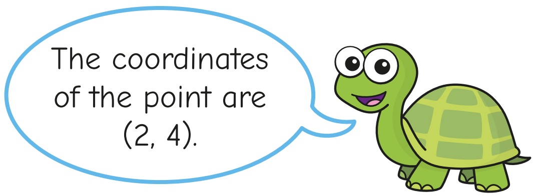
S (–8, –3)

Read and plot points in four quadrants

Reasoning and problem solving

A point is plotted on a coordinate grid.



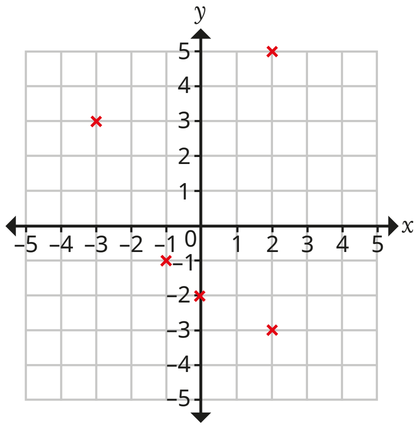


Do you agree with Tiny?

Explain your answer.

No

Amir plots five points on a grid and writes their coordinates.



(2, –5) (3, –3) (–1, –1)
(–2) (2, –3)

Mark Amir's work and make any corrections necessary.

Discuss with a partner what mistakes Amir might have made and why he might have made them.

(2, –5) ✘ (2, 5)

(3, –3) ✘ (–3, 3)

(–1, –1) ✔

(–2) ✘ (0, –2)

(2, –3) ✔

Solve problems with coordinates

White Rose MATHS

Notes and guidance

In this small step, children use their knowledge of coordinates in four quadrants to solve problems, such as working out the coordinates of vertices of polygons.

Children need to be secure in reading and plotting coordinates in all four quadrants. They consider horizontal and vertical lines that go through a known coordinate, using the fact that if they know the x-coordinate of a point on a vertical line, then every point on that line will have the same x-coordinate. Similarly, every point on a horizontal line will have the same y-coordinate. Children then use this information to help find missing coordinates on shapes, both on grids with gridlines and on those without. Finally, they use the properties of shapes to solve problems on coordinate grids, for example using the fact that the opposite sides of a rectangle are equal in length.

Things to look out for

- Some children may need the support of gridlines to work out the coordinates of a point.
- If children confuse the x- and y-values of the coordinates of a point, then coordinates derived from this point will also be incorrect.

Key questions

- Which axis do you look at first when finding the coordinates of a point?
- What do you know about the coordinates of all points on the x-axis/y-axis?
- If you know the coordinates of a point, what do you know about the coordinates of a point that lies on the vertical/horizontal line that passes through the point?
- How can you use the coordinates of these two vertices to work out the coordinates of the other vertices?

Possible sentence stems

- On a horizonal line, the ______-value of the coordinates of any point will remain the same.
- On a vertical line, the ______-value of the coordinates of any point will remain the same.
- If the x-/y-coordinate of the vertex is ______, I know that the x-/y-coordinate of the other vertex must be ______

National Curriculum links

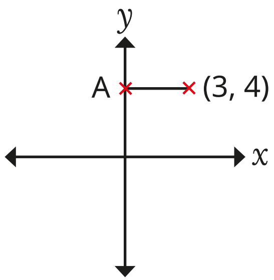
- Describe positions on the full coordinate grid (all four quadrants)

Solve problems with coordinates

White Rose MATHS

Key learning

- A horizontal line is drawn between two coordinates on a grid.



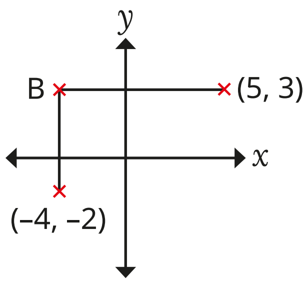
What are the coordinates of point A?

How do you know?

- A horizontal line goes through (5, 3).

A vertical line goes through (–4, –2).

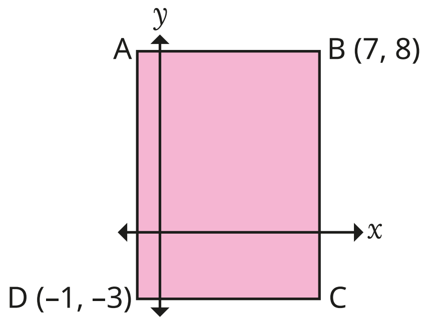
The horizontal line meets the vertical line at point B.



What are the coordinates of point B?

How did you find the coordinates?

- ABCD is a rectangle.

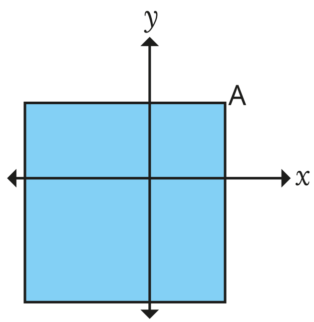


Work out the coordinates of A and C.

- A square has been drawn on a coordinate grid.

The square has a perimeter of 20 units.

Vertex A is at (2, 2).



What are the coordinates of the other three vertices of the square?

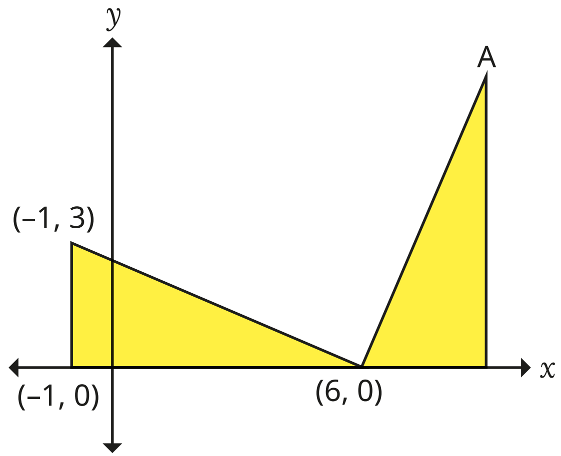
Solve problems with coordinates

Reasoning and problem solving

The diagram shows two identical triangles.

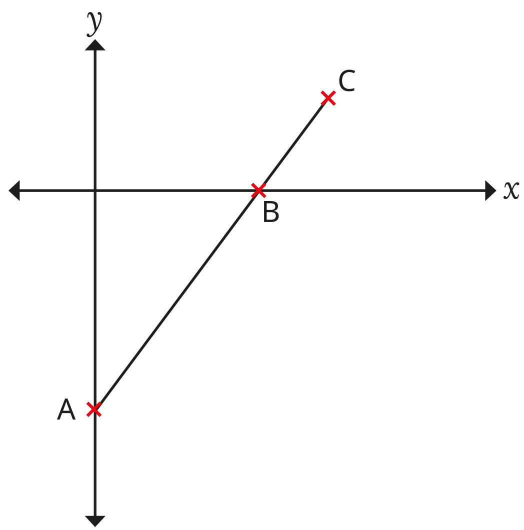
The coordinates of three points are shown.

Work out the coordinates of A.



(9, 7)

ABC is a straight line.



A is the point (0, –10).

B is the point (8, 0).

The distance from A to B is two-thirds of the distance from A to C.

Work out the coordinates of C.

(12, 5)

Translations

Notes and guidance

Now that children have a good understanding of coordinates in all four quadrants, in this small step they move on to translating points and shapes on a coordinate grid. They first experienced translation on a coordinate grid in Year 4, and that learning is now extended to translate in all four quadrants.

Begin by recapping that translating points means to move them. Look first at translations in one direction, either left/right or up/down, before moving on to translations in both directions. Once children have recapped translating single points on a grid, they explore translating shapes, applying the same translation to each vertex of the shape. They should see that the shape looks identical after being translated, but is in a different position on the coordinate grid. Give children opportunities to describe translations as well as perform them. Encourage children to explore the effect of translations on the coordinates.

Things to look out for

- Children may look at the gap between shapes, instead of how far a specific vertex has been translated.
- Children may not give the direction of the translation and/or confuse left and right.
- Children may confuse translation and reflection.

Key questions

- What does "translation" mean?
- How can you translate a point?
- What will the shape look like when it has been translated?
- Which point on the shape will you translate first?
- Will each vertex on a shape be translated in the same way?
- How can you describe the translation?

Possible sentence stems

- Shape A has been translated ______ squares to the right/left and ______ squares up/down.
- (______, ______) translated ______ squares to the right/left is (______, ______).
- (______, ______) translated ______ squares up/down is (______, ______).

National Curriculum links

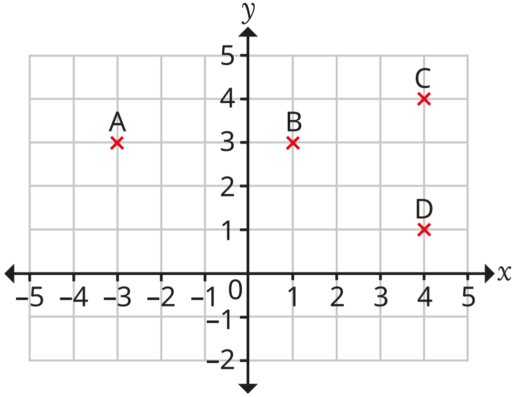
- Draw and translate simple shapes on the coordinate plane, and reflect them in the axes

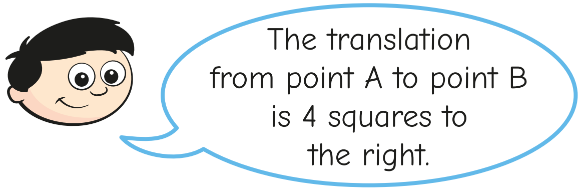
Translations

White Rose MATHS

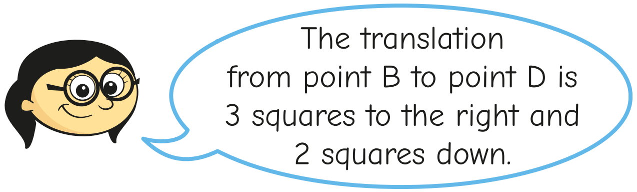
Key learning

- Four points have been marked on a grid.



  - 

    What is the translation from point C to point D?

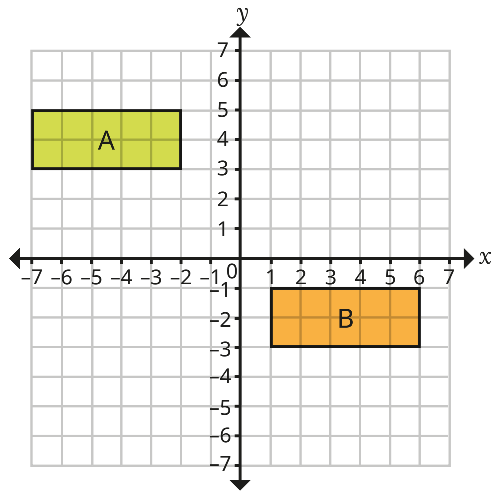
  - 

    What is the translation from point D to point A?

  - Point C is translated 3 squares to the left and 2 squares down.

    What are the coordinates of the new point?

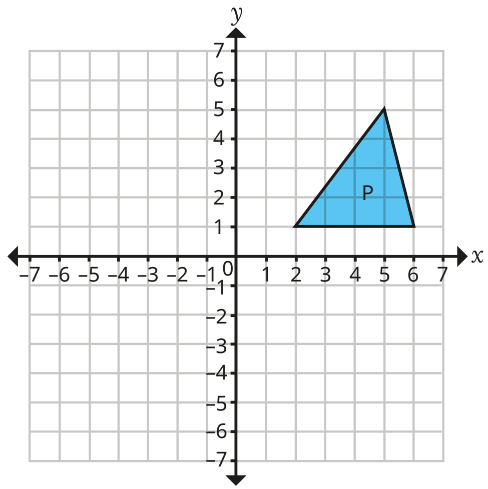
- Describe the translation from shape A to shape B.



  What do you notice about shapes A and B?

- Triangle P is translated 6 squares to the left and 3 squares down.

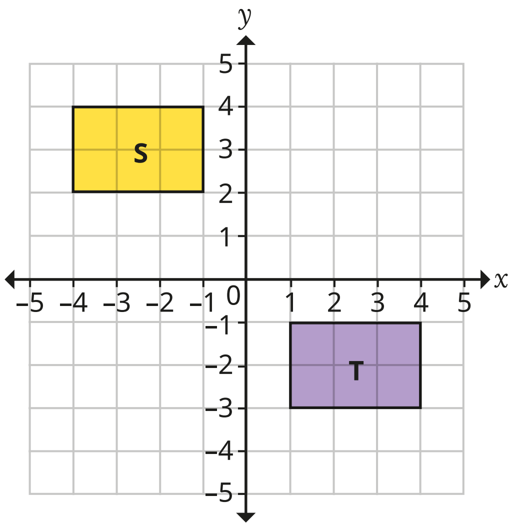
  Draw the new position of the triangle and label it Q.

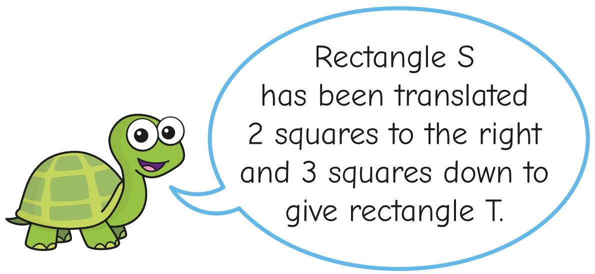


  What do you notice about triangles P and Q?

Translations

Reasoning and problem solving





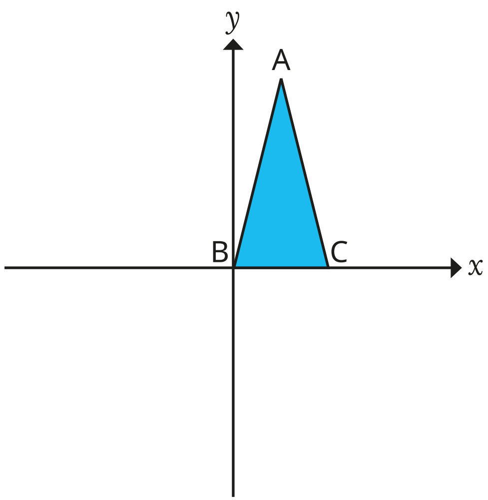
Do you agree with Tiny?

Explain your answer.

No

An isosceles triangle is drawn on a coordinate grid.

Vertex A has the coordinates (2, 5) and vertex B is at (0, 0).



The triangle is translated 4 to the right and 6 down.

What are the new coordinates of vertex C?

(8, −6)

Reflections

White Rose MATHS

Notes and guidance

Children reflected shapes in the first quadrant of coordinate grids in Year 5, both with gridlines and without, using lines parallel to the x- or y-axis. In this small step, that learning is revisited and extended to include reflections across all four quadrants.

It can be useful to use mirrors to explore reflection and to see that a reflected image looks identical to the original image, but faces the opposite direction. Start with reflecting points and shapes on a coordinate grid in the x- or y-axis. Children should count how far away each vertex is from the axis and use this to work out the coordinates of each vertex in the reflected shape. They could then be stretched to reflect shapes in lines that are parallel to each axis. This should be done both with gridlines and without, giving children the opportunity to work out reflections both by counting squares and by calculation.

Things to look out for

- Children may confuse translation and reflection.
- Children may draw the reflection of a shape in the same orientation as the original shape.
- Children may miscount the distances to/from the mirror line.

Key questions

- How is reflecting similar to translating? How is it different?
- How does reflecting one vertex at a time make it easier to reflect the whole shape?
- How far away is the vertex from the mirror line? How far away does the corresponding vertex need to be from the mirror line?
- How can you check if the reflected shape looks like it is in the correct place?
- Does the reflection of a shape always, sometimes or never face the same way as the original shape?

Possible sentence stems

- Shape ______ has been reflected in the ______-axis.
- The vertex is ______ squares away from the mirror line, so the corresponding vertex also needs to be ______ squares away from the mirror line.

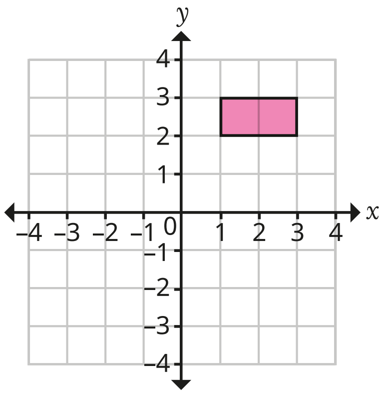
National Curriculum links

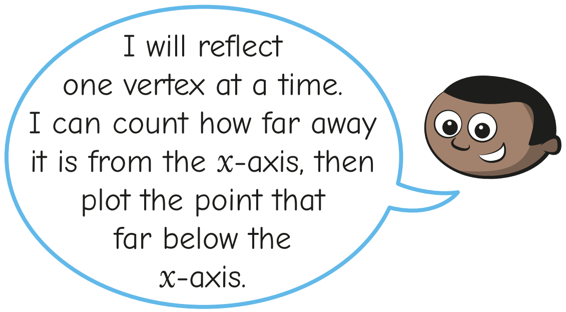
- Draw and translate simple shapes on the coordinate plane, and reflect them in the axes

Reflections

Key learning

- Mo is reflecting this rectangle in the x-axis.





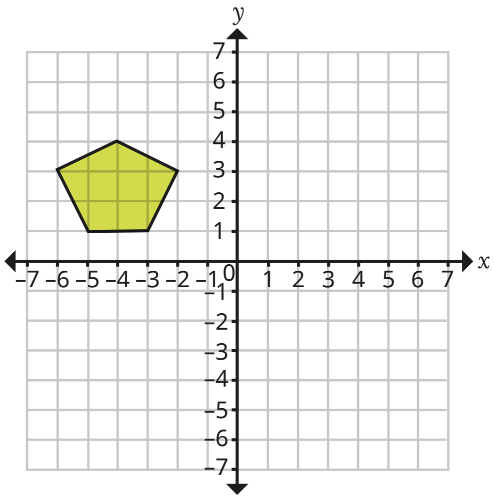
Use Mo's method to complete the reflection.

What are the coordinates of each vertex of the reflected rectangle?

What do you notice?

- Reflect this shape in the x-axis and in the y-axis.

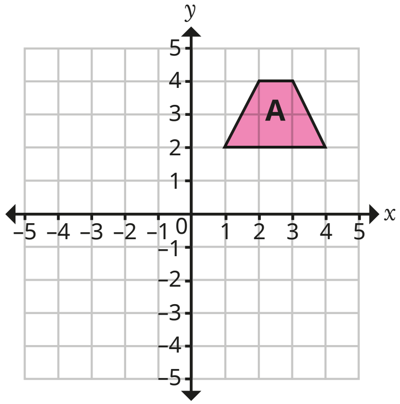
What do you notice about the reflections?



- Reflect trapezium A in the x-axis. Label the new trapezium B.

Reflect trapezium B in the y-axis. Label the new trapezium C.

Complete the table with the coordinates of the vertices of each shape.

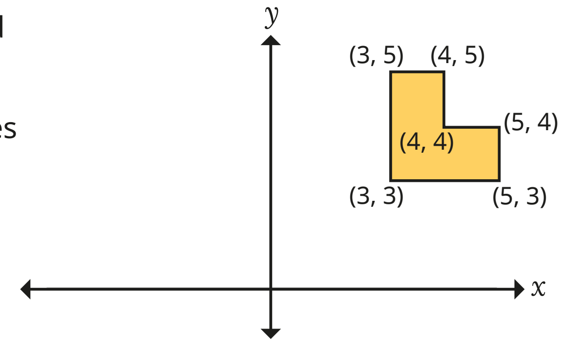


A	B	C
(1, 2)		
(4, 2)		
(3, 4)		
(2, 4)		

What do you notice?

- The hexagon is reflected in the y-axis.

Work out the coordinates of the vertices of the reflected shape.

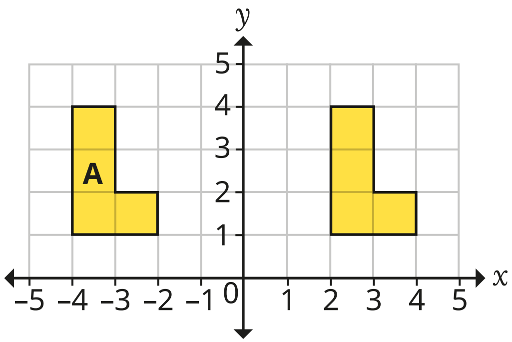


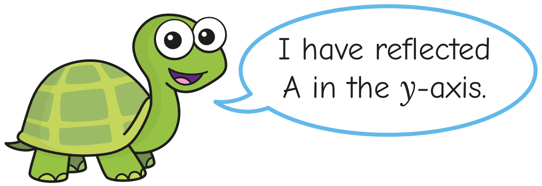
Reflections

White Rose MATHS

Reasoning and problem solving

Tiny is reflecting shapes.



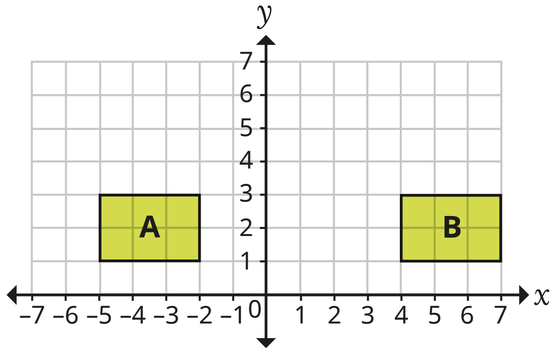


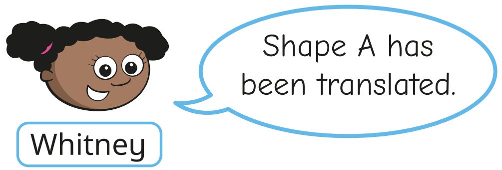
Do you agree with Tiny?

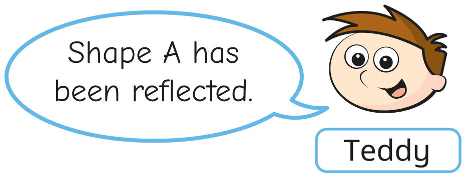
Explain your answer.

No

Shapes A and B are on a coordinate grid.







Who is correct?

Explain your answer.

Both could be correct.

Shape A could have been reflected in the vertical line through (1, 0) or translated 9 squares to the right.