



What can we learn from star patterns?

Geometry teaching pack



GEOMETRY ACTIVITIES

ENQUIRY OF LEARNING What can we learn from star patterns?

The six activities in this geometry pack have been developed to explore with students the fascinating geometry of star patterns. They can be used to support learning about shape in maths, to enrich an exploration of star designs in art or to teach geometry as a standalone activity. They could also be used to introduce students to the principle of Geometry. You can find out more about Nature's principles of Harmony on The Harmony Project website.

For each activity, step-by-step text instructions are provided as a guide for teachers, with accompanying diagrams and lists of the resources students will need to complete each activity. There are also photocopiable templates - each student will need a copy to complete each activity.

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WHY GEOMETRY?

Learning the geometry of Nature provides students with a new way of looking at the world. The observational skills and careful drawings that are required to recreate this geometry can have a powerful impact on students' understanding of Nature and their place in it. If we are to create a sustainable future, we need to see the world through a different lens, to understand that the patterns of life that exist around us, also exist in us. This way of seeing the world means we view everything from a place of connection, rather than separation. This sense of connection is an essential part of learning to live sustainably. After all, the word 'Harmony' means joined or connected.

GEOMETRY ACTIVITY 1

ENQUIRY OF LEARNING What can we learn from star patterns?

LEARNING QUESTION What stars can we make with triangles?

This activity can be used to support learning about number patterns in maths or as a standalone project.

In this activity, students use a template to draw a series of triangles, all of which have their vertices located on the circumference of a circle. These triangles build up to create a 12-pointed star. The name for this star shape in geometry is a 'dodecagram'.

There are two common ways to draw a dodecagram using 12 points spaced equally around the circumference of a circle. The first involves connecting every fourth point around the edge of the circle to draw four triangles. The second involves connecting every fifth point. Both methods result in the creation of a 12-pointed star shape, each with a slightly different internal structure. A further method involving squares is explored in Activity 2.

This activity helps students to recognise patterns and to develop a deeper understanding of the relationship between shapes – in this case triangles and circles – and numbers. It also encourages creativity and problem-solving.

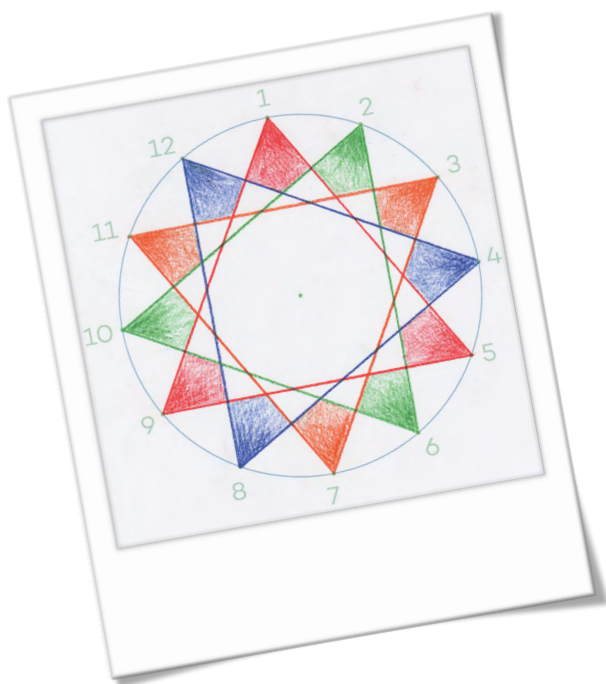
YOU WILL NEED

Copies of Resource 1A
A ruler
An HB pencil
A good-quality eraser
Coloured pencils



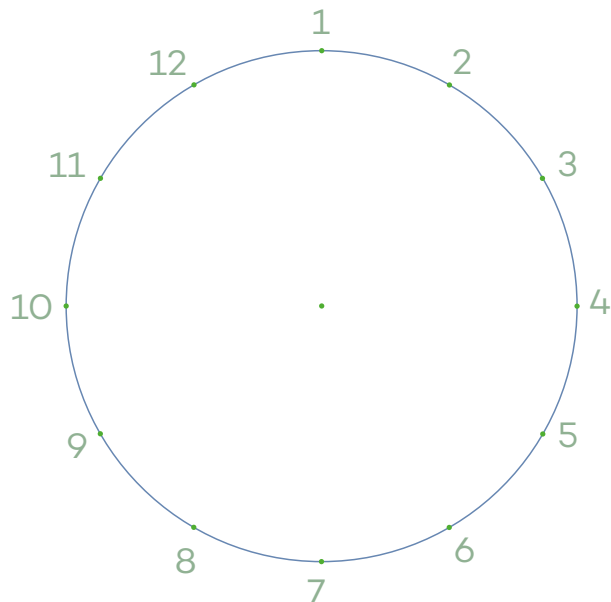
DID YOU KNOW?

A dodecagram (12-pointed star) can represent a number of things. For example, it could represent the 12 hours marked on a clock face or the 12 months in a year. This helps us remember how time is organised and how nature changes throughout the year.



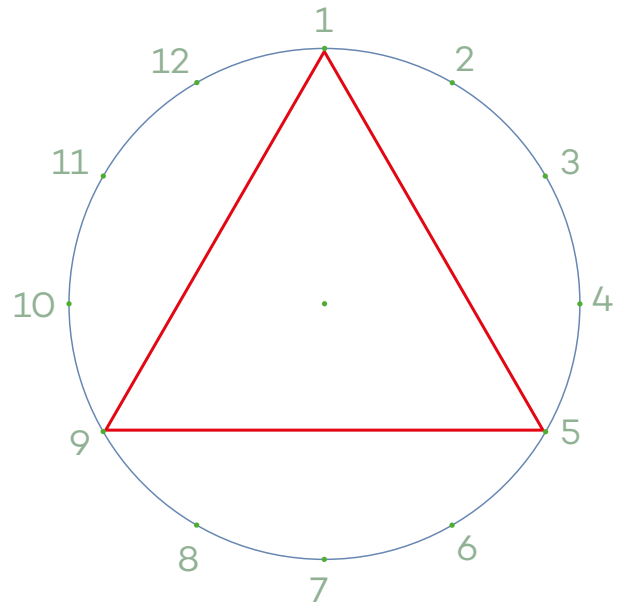
STEP 1 Get to know the 12-point template

Using copies of Resource 1A, take a moment to familiarise yourself with the template. Note the similarities and differences between the template and a clock face (note that in the template, the number 1 appears at the very top of the circle where the number 12 would be on a clock).



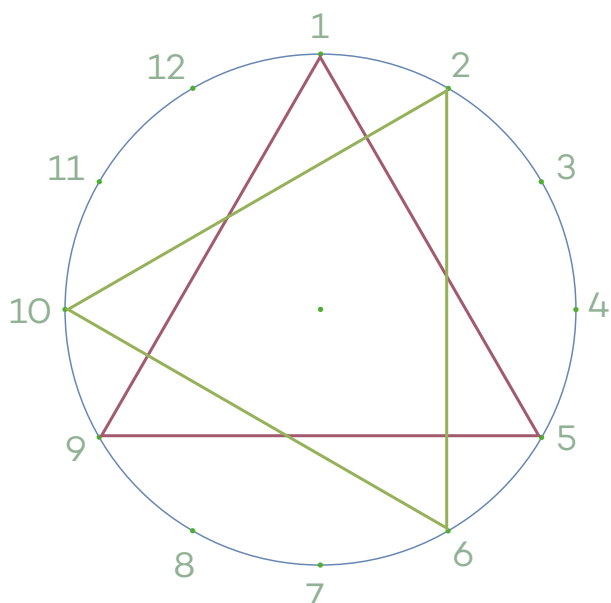
STEP 2 Draw the first triangle

Using a ruler, draw three lines to connect points 1 and 5, 5 and 9, and 9 and 1. This will create the first triangle in your drawing.



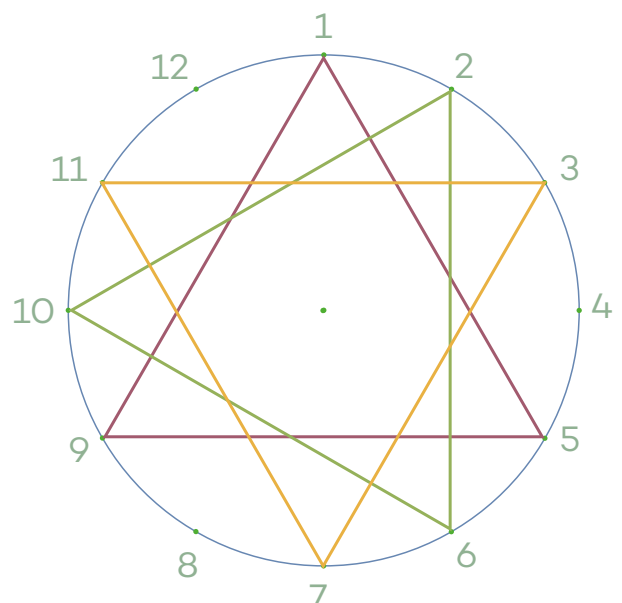
STEP 3 Draw the second triangle

Using a ruler, draw three lines to connect points 2 and 6, 6 and 10, and 10 and 2. This will create the second triangle in your drawing. You might want to continue using an HB pencil, or draw each triangle in a different colour so you can see more clearly how the dodecagram is constructed.



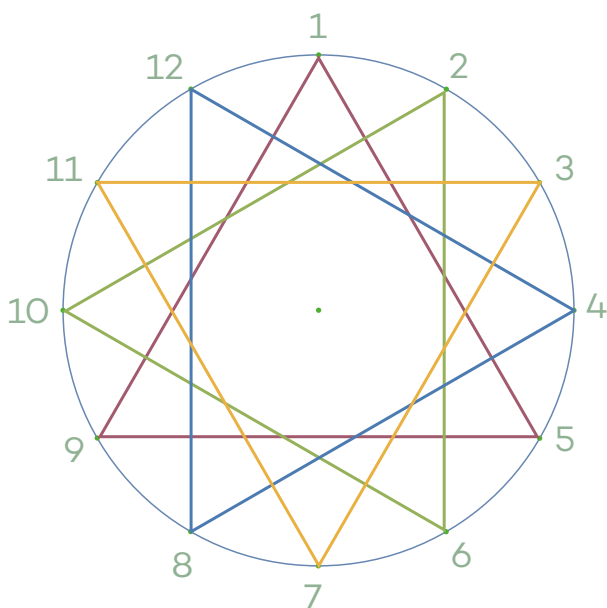
STEP 4 Draw the third triangle

To draw the third triangle, connect points 3 and 7, 7 and 11, and 11 and 3.



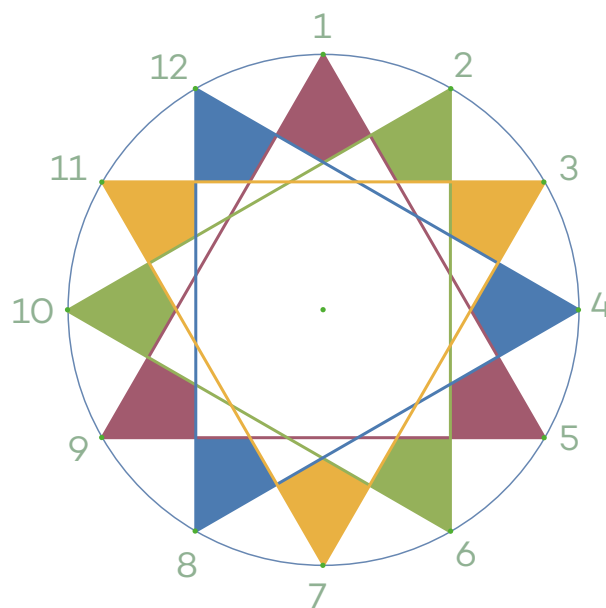
STEP 5 Draw the fourth and final triangle

To draw the final triangle, connect points 4 and 8, 8 and 12, and 12 and 4.



STEP 6 Colour the kite shapes

If you look closely, you will see 12 kite shapes located at the points of the dodecagram you have drawn. You could colour these to make the points of the 12-pointed star stand out.



TEACHER TIP

This activity provides a fantastic 'jumping off' point for exploring number patterns in maths. You might ask children for example:

What is the sum of the three numbers you used to draw each triangle? Is there a pattern?

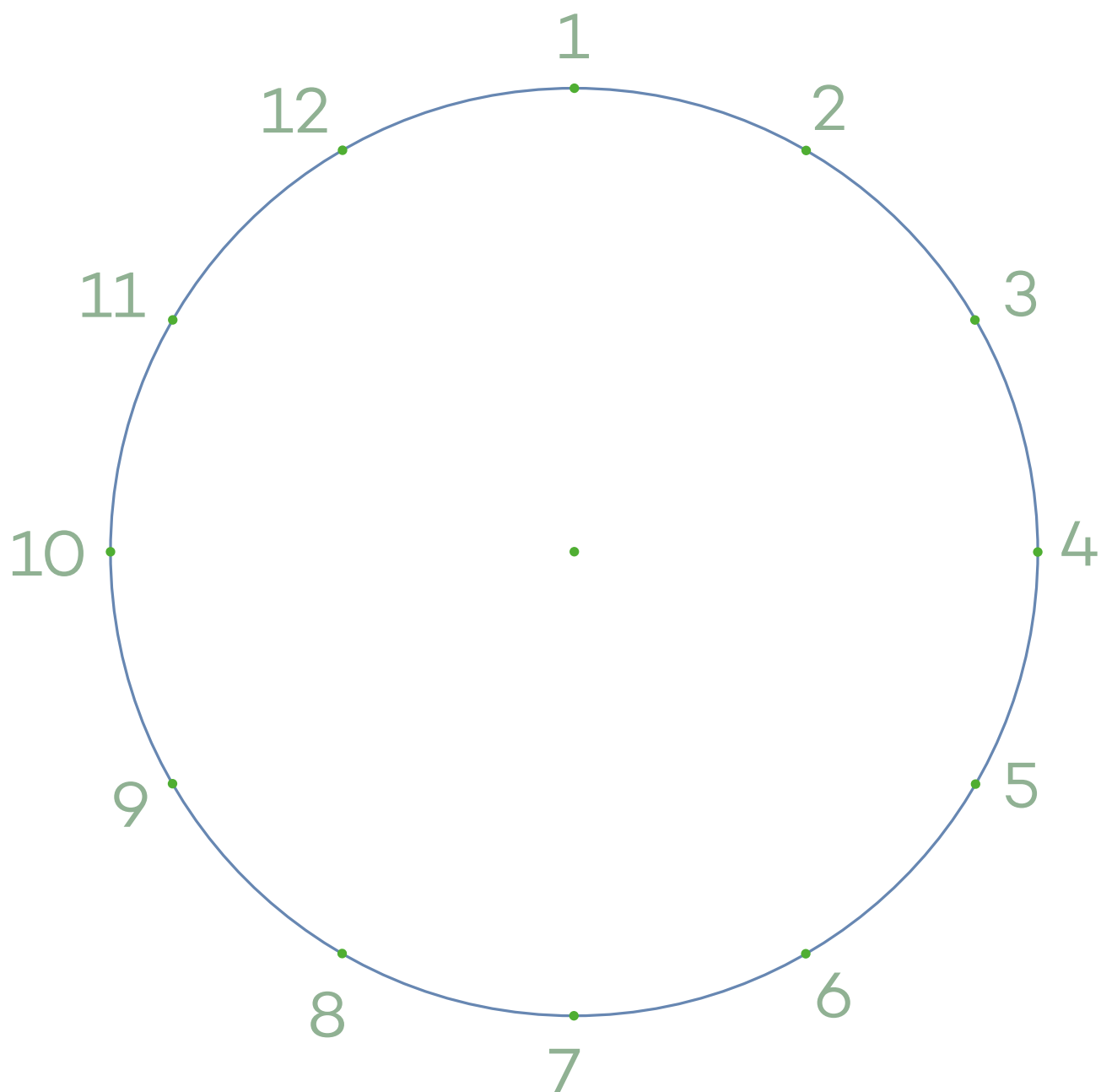
$$1 + 5 + 9 = 15$$

$$2 + 6 + 10 = 18$$

$$3 + 7 + 11 = 21$$

What would the next five numbers in this number sequence be?

PHOTOCOPIABLE RESOURCE 1A



GEOMETRY ACTIVITY 2

ENQUIRY OF LEARNING What can we learn from star patterns?

LEARNING QUESTION What stars can we make with other shapes?

The three activities that make up Activity 2 can be used to support learning about number patterns and shape in maths, or as a standalone project.

In Activity 2A, students use a template to draw a series of squares, all of which have their vertices located on the circumference of a circle. These squares build up to create a 12-pointed star – this is called a ‘dodecagram’. In Activity 2B, they go on to create a dodecagram using hexagons, while in Activity 2C, they explore how pairs of parallel lines can also be used to draw a 12-pointed star.

These activities help children to recognise patterns and to develop a deeper understanding of the relationship between shapes – in this case squares, hexagons and circles – and numbers. It also encourages creativity and problem-solving.

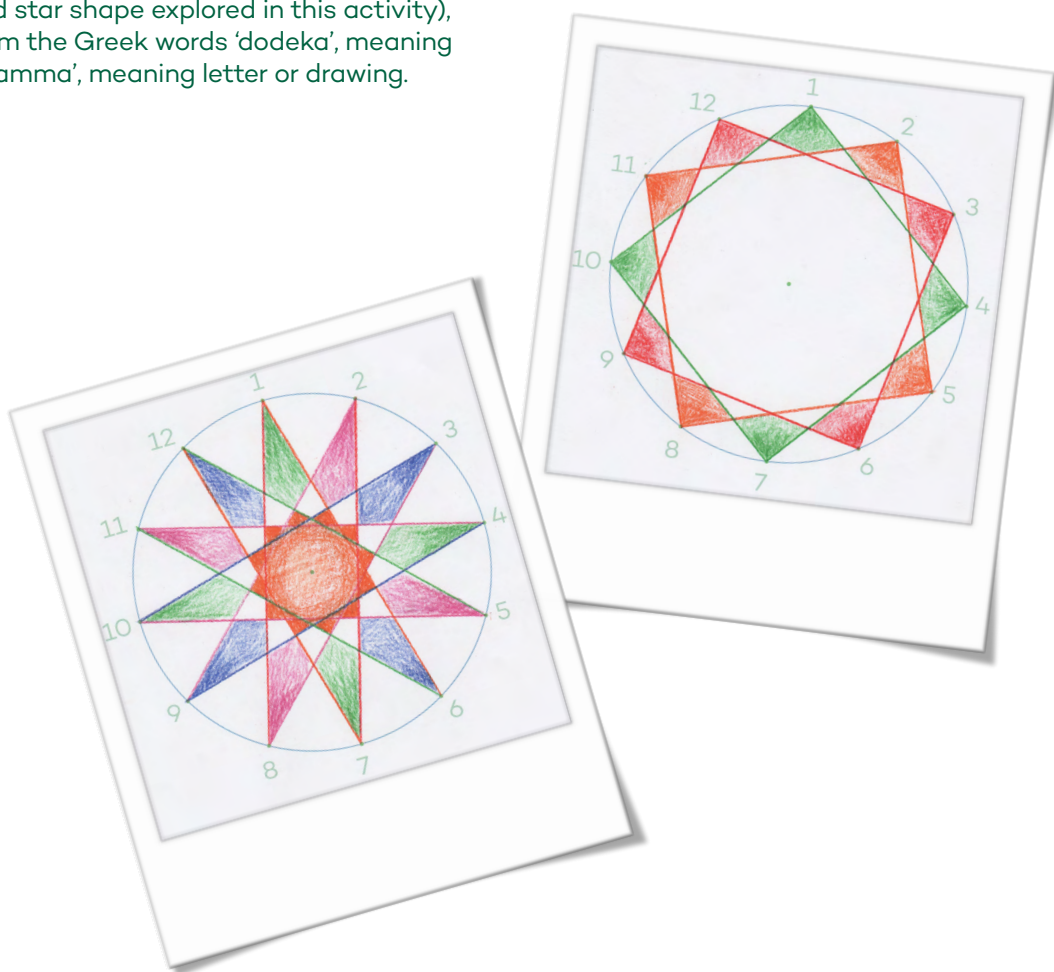
YOU WILL NEED

Copies of Resource 2A
A ruler
An HB pencil
A good-quality eraser
Coloured pencils



DID YOU KNOW?

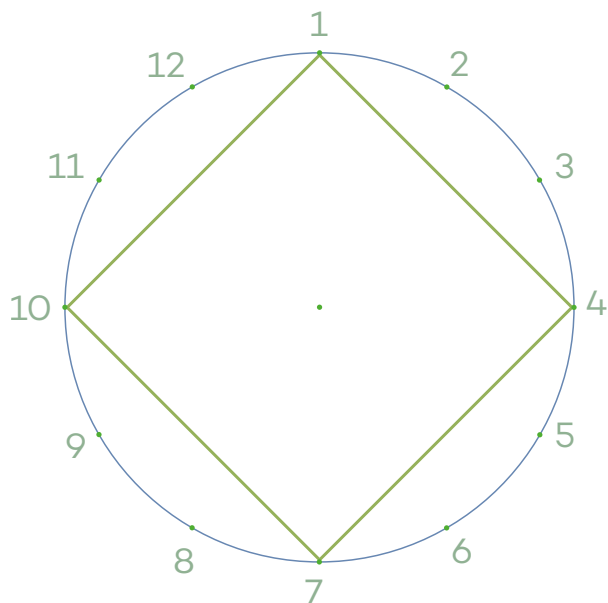
The word ‘dodecagram’ (the name for the 12-pointed star shape explored in this activity), comes from the Greek words ‘dodeka’, meaning 12, and ‘gramma’, meaning letter or drawing.



ACTIVITY 2A

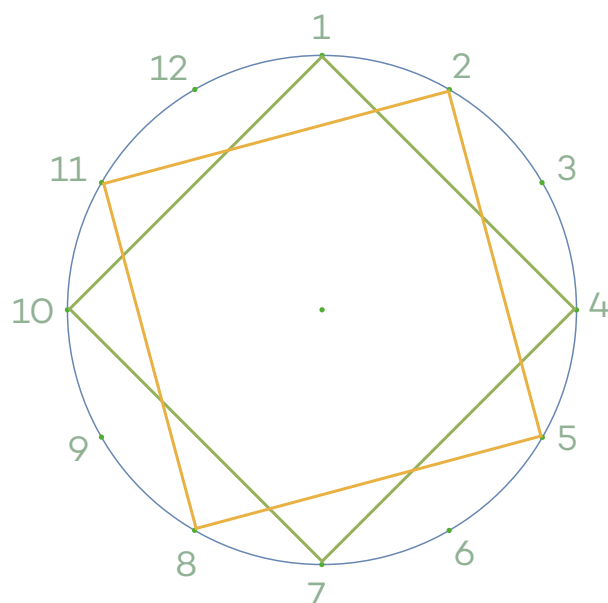
STEP 1 Draw a dynamic square

A dynamic square is the name given to a square resting on its point, like the one below. Draw this square on the template in Resource 2A by using a ruler to connect points 1 and 4, 4 and 7, 7 and 10, and 10 and 1.



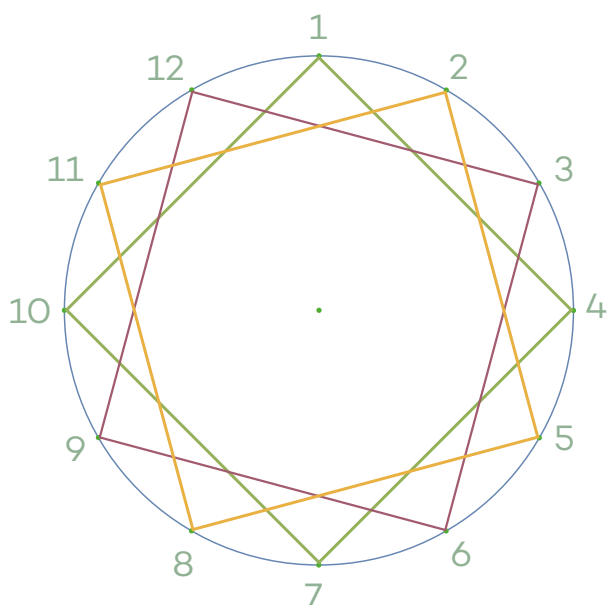
STEP 2 Draw a second square

Draw a second square by joining points 2 and 5, 5 and 8, 8 and 11, and 11 and 2. This will create the second square in your drawing. You might want to continue using an HB pencil, or draw each square in a different colour so you can see more clearly how the dodecagram is constructed.



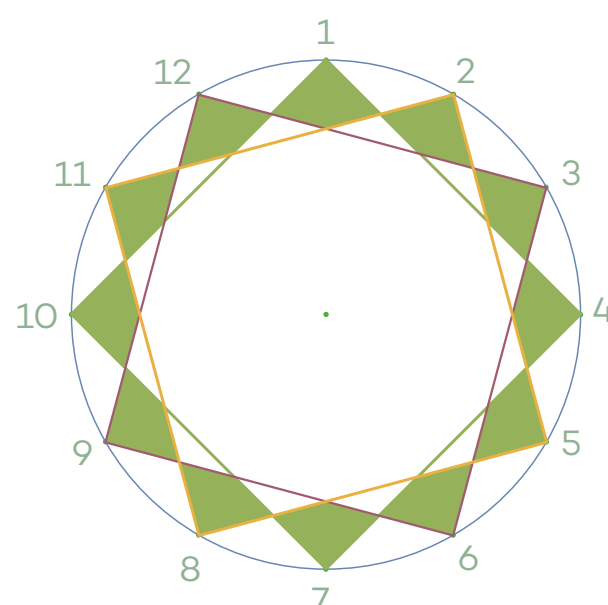
STEP 3 Draw the third square

To draw the third square, use a ruler to connect points 3 and 6, 6 and 9, 9 and 12, and 12 and 3.



STEP 4 Colour the kite shapes

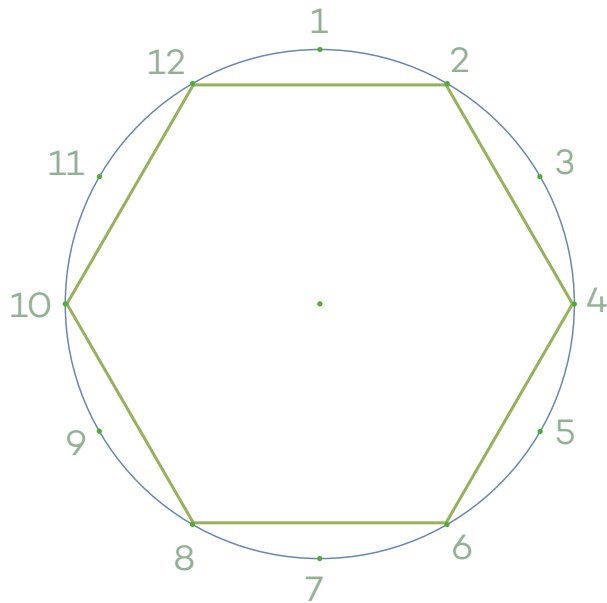
If you look closely, you will see 12 kite shapes located at the points of the dodecagram you have drawn. You could colour these to make the points of the 12-pointed star stand out.



ACTIVITY 2B

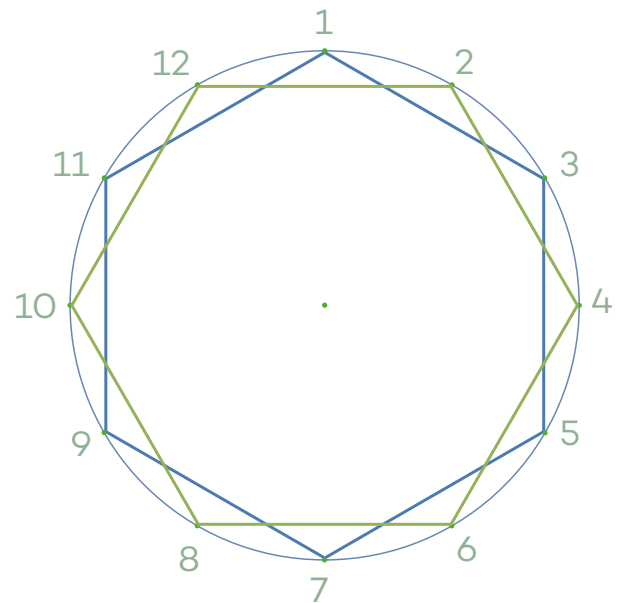
STEP 1 Draw a static hexagon

A dodecagram can also be drawn using a pair of hexagons. Using a copy of the template in Resource 2A, draw a static hexagon (a hexagon resting on one of its sides) by joining points 2 and 4, 4 and 6, 6 and 8, 8 and 10, 10 and 12, and 12 and 2.



STEP 2 Draw a dynamic hexagon

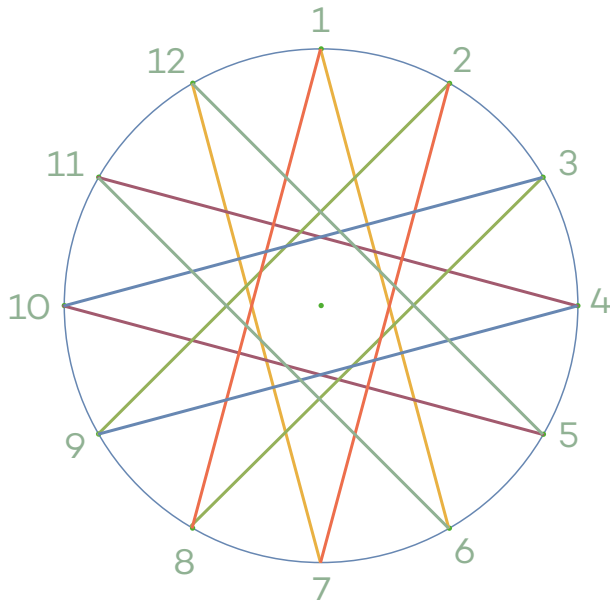
Now use a ruler to draw a dynamic hexagon (a hexagon resting on one point) by connecting points 1 and 3, 3 and 5, 5 and 7, 7 and 9, 9 and 11, and 11 and 1. What shape can you see repeated at each point of this dodecagram?



ACTIVITY 2C

STEP 1 Draw pairs of parallel lines

The template on Resource 2A can also be used to create a dodecagram using pairs of parallel lines. For example, start by using a ruler to connect points 1 and 8 then draw a second line parallel to the first that connects points 2 and 7.



TEACHER TIP

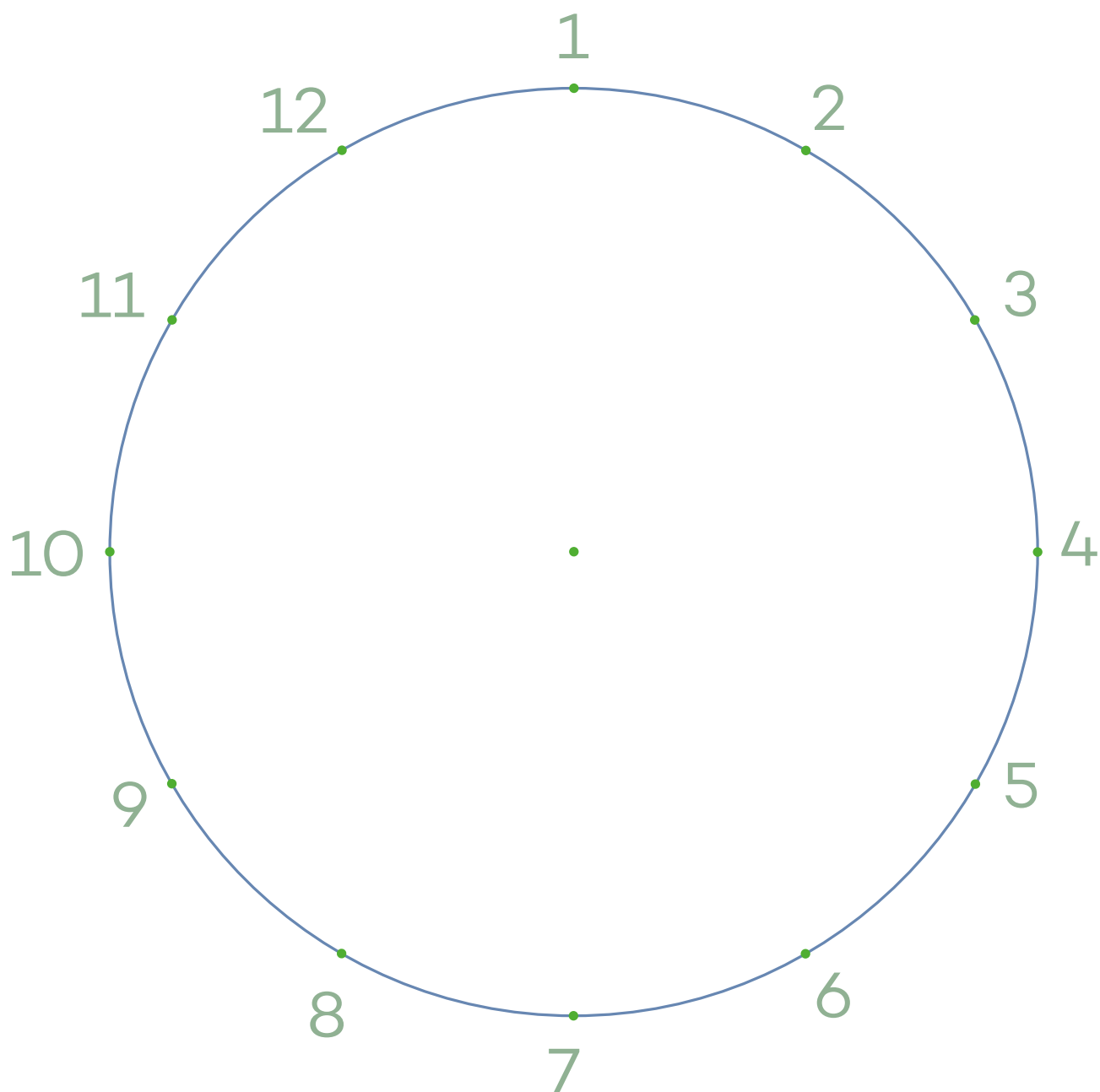
You will need to draw further pairs of parallel lines to complete the dodecagram. Challenge your students to work out which points these lines would connect. Ask them:

How will you work methodically to find the answer? What number patterns can you find to help you?

ANSWER:

- 1 and 8, 2 and 7 (already drawn)
- 2 and 9, 3 and 8
- 3 and 10, 4 and 9
- 4 and 11, 5 and 10
- 5 and 12, 6 and 11
- 6 and 1, 7 and 12

PHOTOCOPIABLE RESOURCE 2A



GEOMETRY ACTIVITY 3

ENQUIRY OF LEARNING What can we learn from star patterns?

LEARNING QUESTION What stars can we make that have 16 points?

The two activities that make up Activity 3 can be used to support learning about shape or number in maths, or as standalone projects.

In Activity 3A, students use a template to draw a series of squares, all of which have their vertices located on the circumference of a circle. These squares build up to create a 16-pointed star. In Activity 3B, they go on to explore how pairs of parallel lines can be used to draw an eight-pointed star.

These activities help children to recognise patterns and to develop a deeper understanding of the relationship between shapes – in this case squares and circles – and numbers. They also encourage creativity and problem-solving.

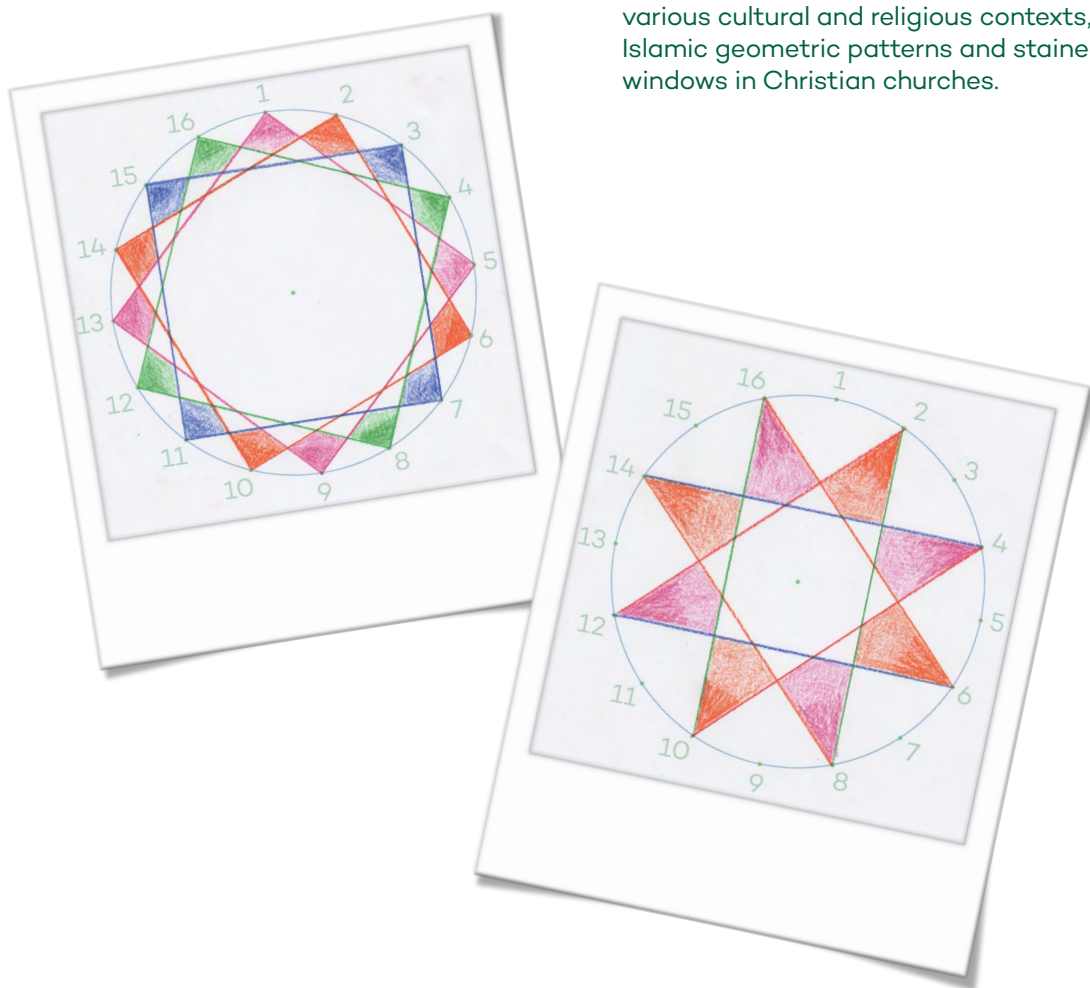
YOU WILL NEED

Copies of Resource 3A
A ruler
An HB pencil
A good-quality eraser
Coloured pencils



DID YOU KNOW?

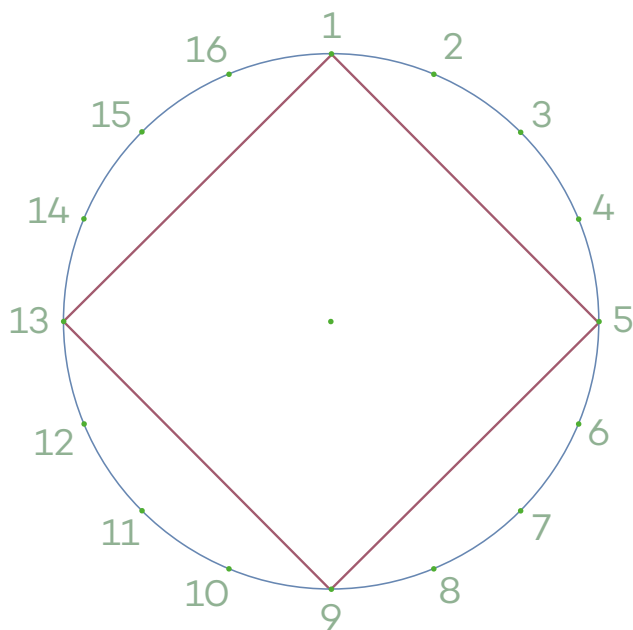
The 16-pointed and eight-pointed stars explored in this activity are often used in art, architecture and design due to their aesthetic appeal and symmetry. They can be found in various cultural and religious contexts, including Islamic geometric patterns and stained glass windows in Christian churches.



ACTIVITY 3A

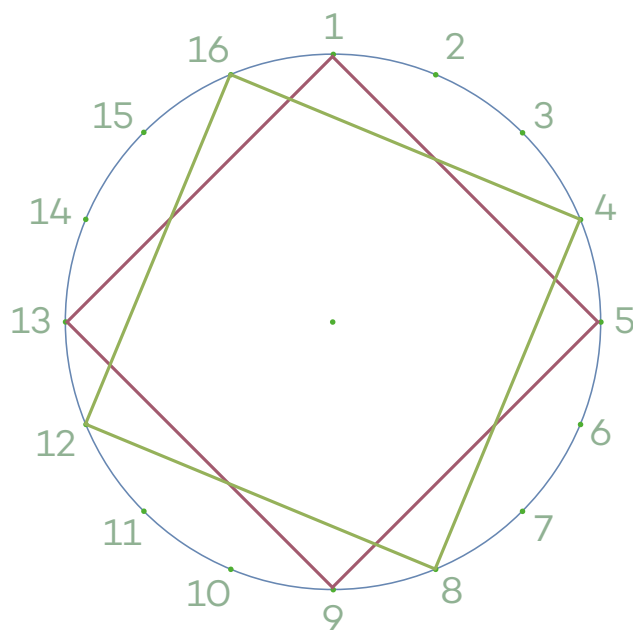
STEP 1 Draw a dynamic square

A dynamic square is the name given to a square resting on its point, like the one below. Draw this square on the template in Resource 3A by using a ruler to connect points 1 and 5, 5 and 9, 9 and 13, and 13 and 1.



STEP 2 Draw a second square

Draw a second square by joining points 16 and 4, 4 and 8, 8 and 12, and 12 and 16. This will create the second square in your drawing. You might want to continue using an HB pencil, or draw each square in a different colour so you can see more clearly how the 16-pointed star is constructed.



TEACHER TIP

An additional element of maths learning can be introduced to this activity after the children have completed Step 1 by asking them:

In total, how many squares like this one will you be able to draw on this template? How do you know?

How could you explain this mathematically?

e.g. A square has four vertices.

The template has 16 points.

$$16 \div 4 = 4$$

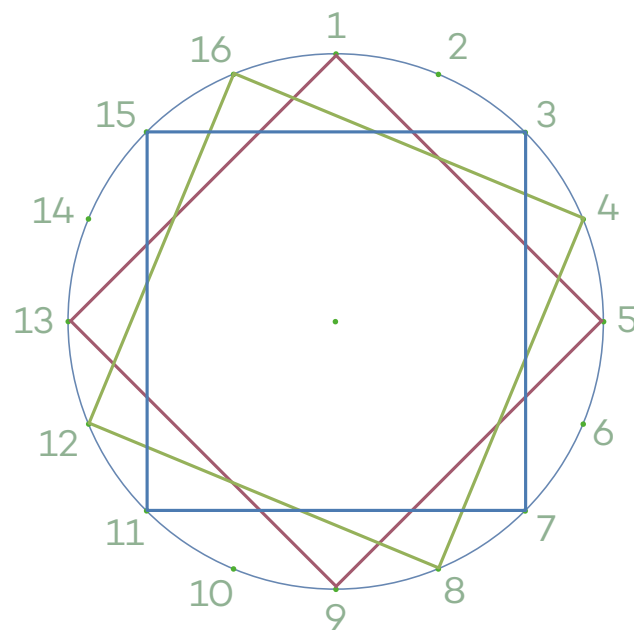
$$\text{OR } 4 + 4 + 4 + 4 = 16$$

$$\text{OR } 4 \times 4 = 16$$

You can draw four squares in total.

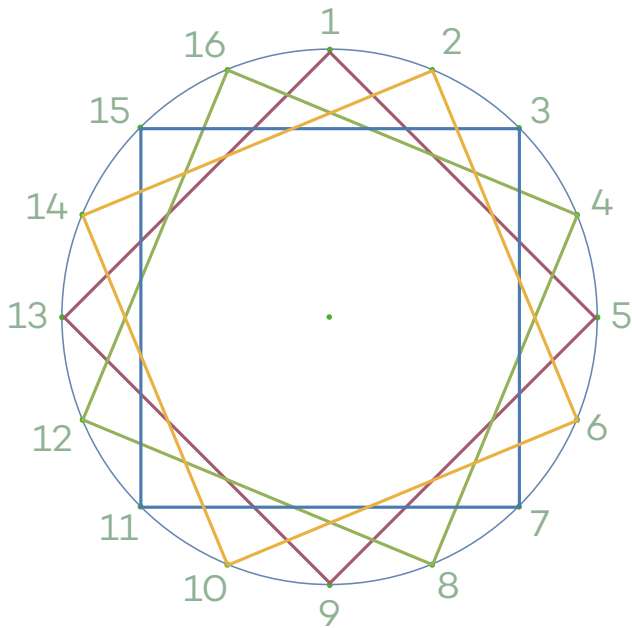
STEP 3 Draw the third square

To draw the third square, use a ruler to connect points 15 and 3, 3 and 7, 7 and 11, and 11 and 15.



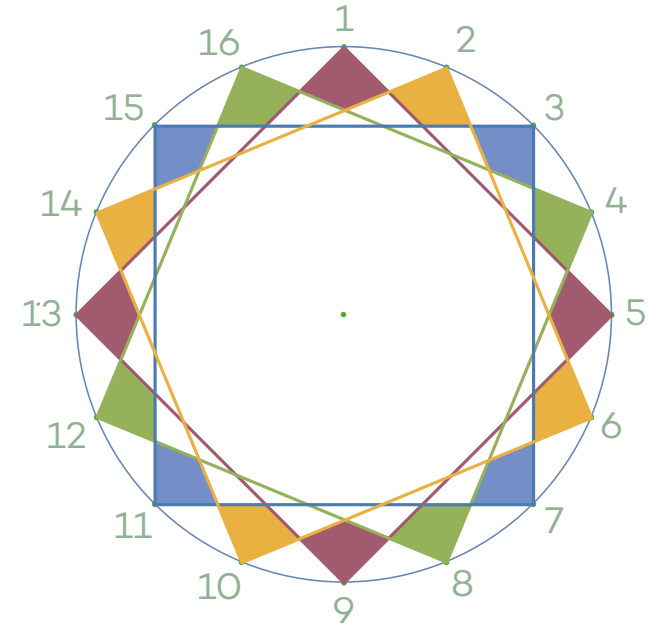
STEP 4 Draw the final square

The final square is drawn by connecting points 14 and 2, 2 and 6, 6 and 10, and 10 and 14.



STEP 5 Colour the kite shapes

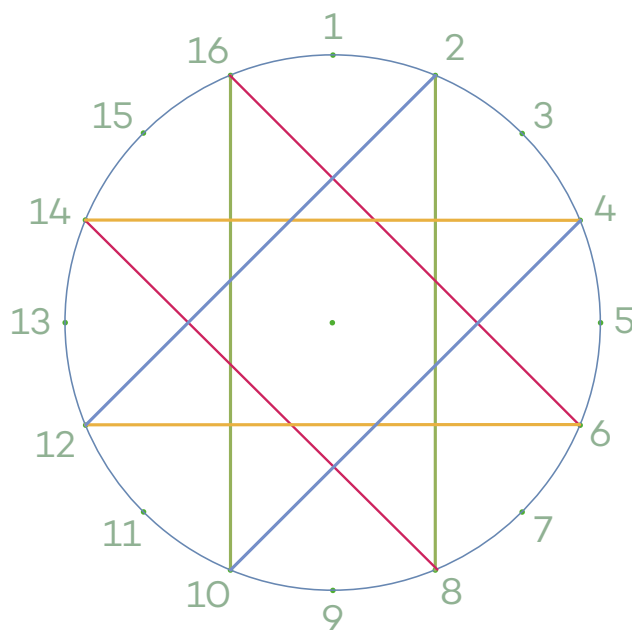
If you look closely, you will see 16 kite shapes located at the points of the star you have drawn. You could colour these to make them stand out.



ACTIVITY 3B

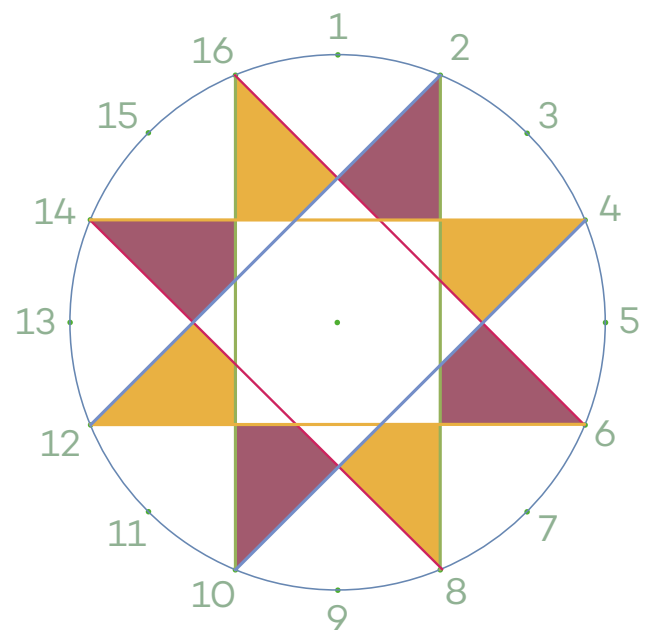
STEP 1 Draw pairs of parallel lines

The template on Resource 3A can also be used to create an eight-pointed star using pairs of parallel lines. For example, start by using a ruler to connect points 2 and 8 then draw a second line parallel to the first that connects points 10 and 16. How many further pairs of parallel lines would you need to draw to complete the star?

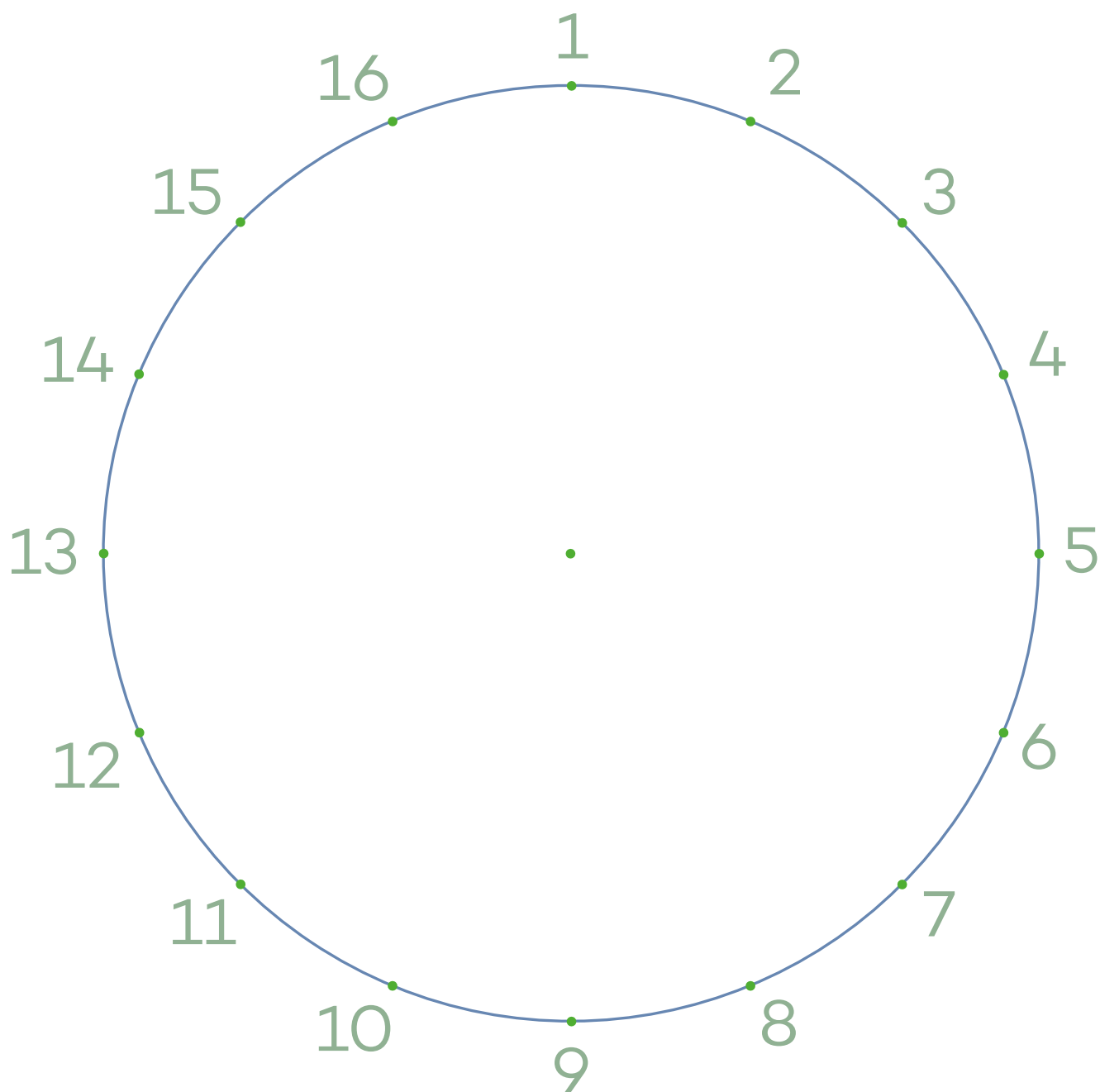


STEP 2 Shade the eight-pointed star

Once the star is complete, you could shade the kite shapes at its points, alternating between two colours to create a pattern.



PHOTOCOPIABLE RESOURCE 3A



GEOMETRY ACTIVITY 4

ENQUIRY OF LEARNING What can we learn from star patterns?

LEARNING QUESTION What kind of star can we draw in a square?

The two activities that make up Activity 4 can be used to support learning about shape in maths, or as standalone projects.

In Activity 4A, students draw an eight-pointed, unicursal star using the vertices and the mid-points of each side of a square. These are numbered 1-8 in the template in Resource 4A.

A unicursal star is a special kind of star that you can draw without lifting your pencil from the paper and without retracing any lines. The word 'unicursal' comes from two words: 'uni' meaning one or single, and 'cursal' meaning going around or following a path. So, a unicursal star is a star that you can draw in one continuous path. Unicursal stars are interesting because they show us how shapes can be created with a single, continuous line, and they can be fun to draw and explore!

In Activity 4B, students find as many right-angled triangles as they can within the unicursal star they drew in Activity 4A.

YOU WILL NEED

Copies of Resource 4A

A ruler

An HB pencil

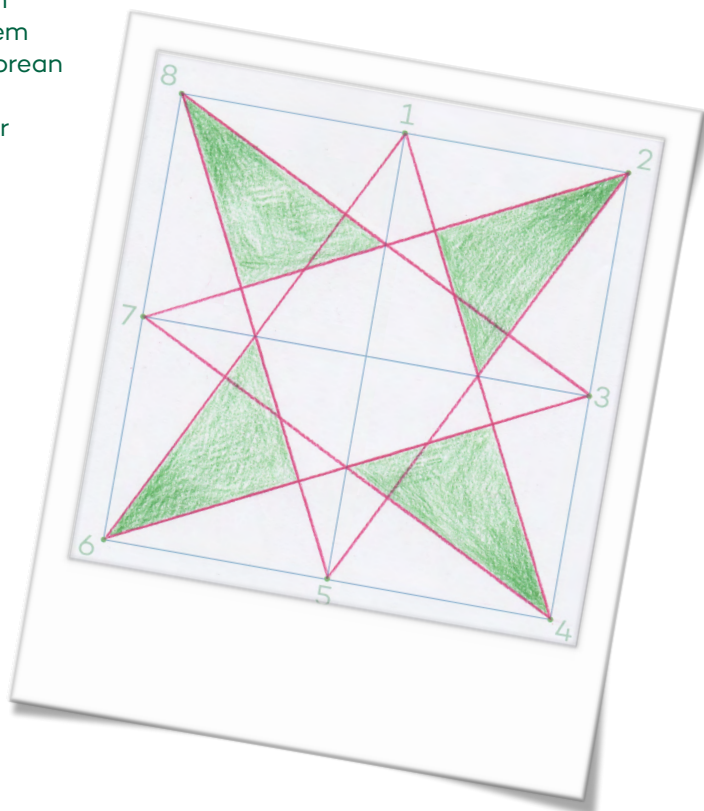
A good-quality eraser

Coloured pencils

Optional: right-angled pieces of card, or similar, for support

DID YOU KNOW?

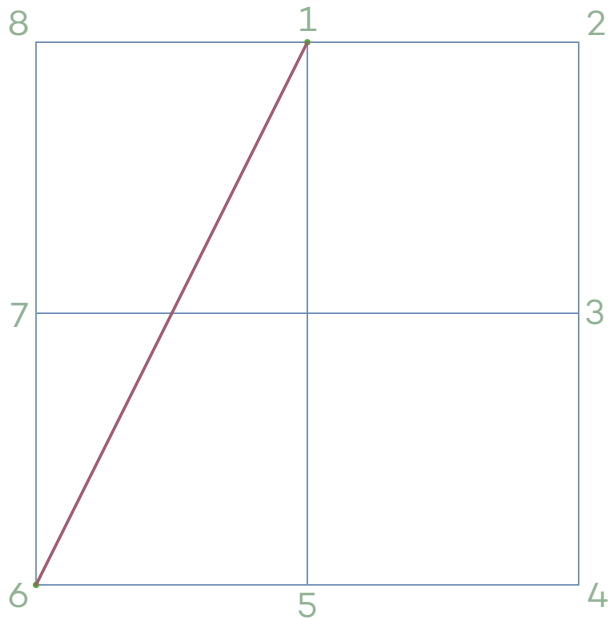
Some right-angled triangles have sides with lengths that are whole numbers, making them easy to remember. These are called Pythagorean triples. One famous example is the 3-4-5 triangle, where the sides are three units, four units and five units long.



ACTIVITY 4A

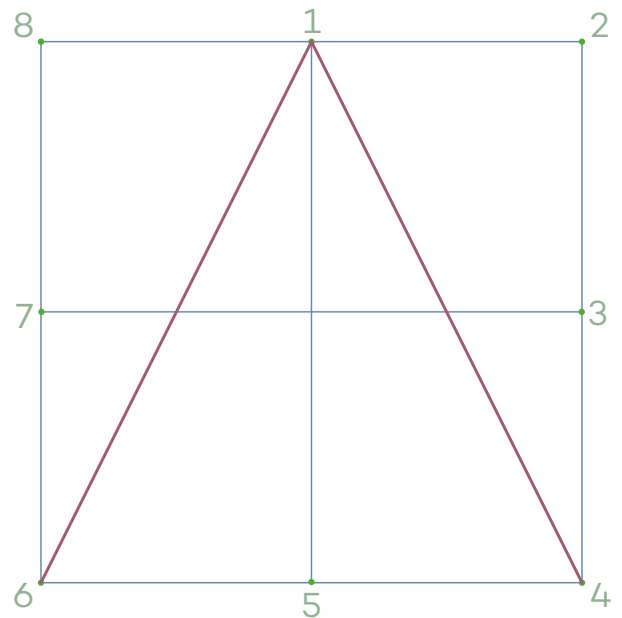
STEP 1 Draw the first line

Use a ruler to connect points 6 and 1 on the template in Resource 4A.



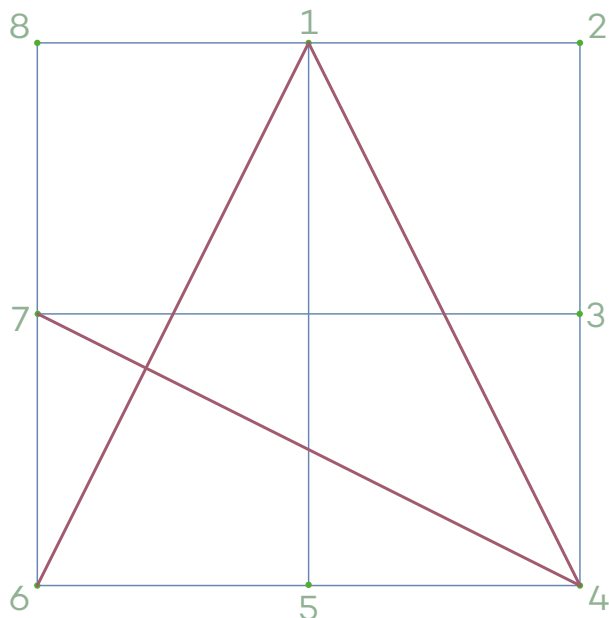
STEP 2 Draw the second line

Use a ruler to draw a second line connecting points 1 and 4.



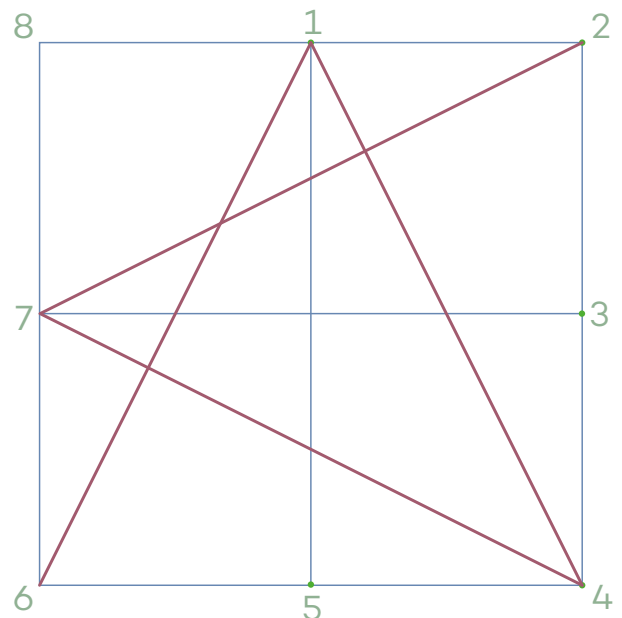
STEP 3 Draw the third line

The third line should connect points 4 and 7.



STEP 4 Draw the fourth line

Next, use a ruler to draw a line connecting points 7 and 2.

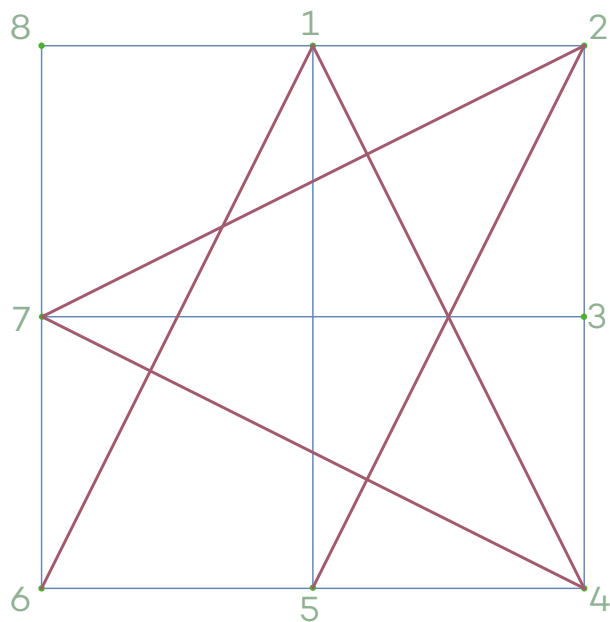


TEACHER TIP

Before starting Step 1, you could take a moment to familiarise students with the template in Resource 4A and extend their thinking about shape. You might ask them: *How many squares can you see in total in the template? How many rectangles? Then ask: What do you notice about where the odd numbers are located around the edge of the largest square? And the even numbers?*

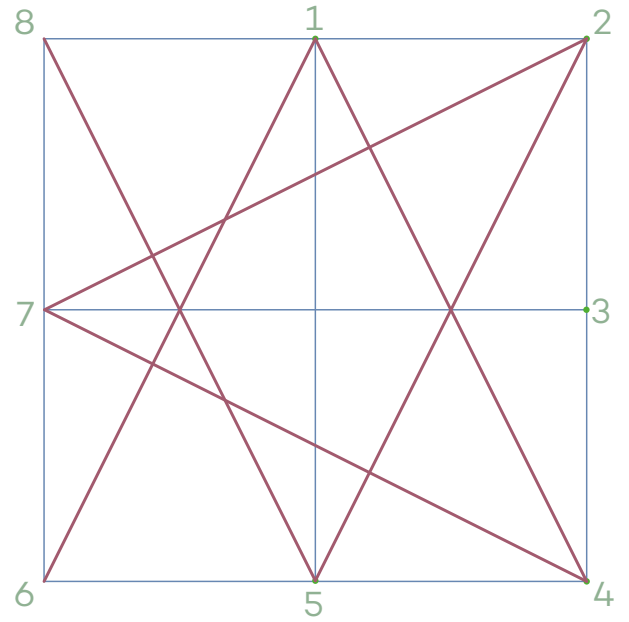
STEP 5 Draw the fifth line

Now connect points 2 and 5...



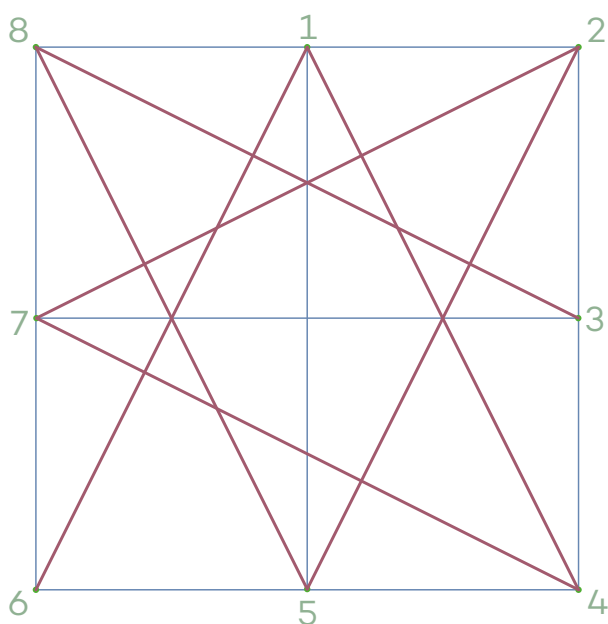
STEP 6 Draw the sixth line

...and then points 5 and 8. Don't forget to use a ruler!



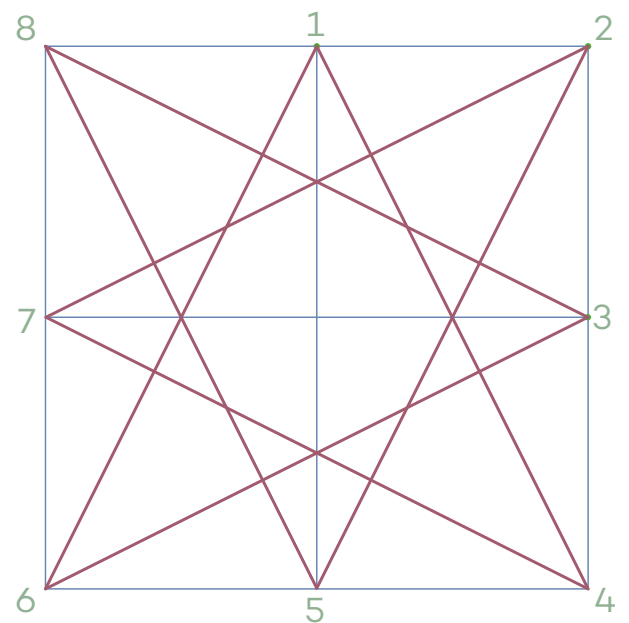
STEP 7 Draw the seventh line

Next, draw a straight line between points 8 and 3.



STEP 8 Draw the final, eighth line

Complete the drawing by drawing a line connecting points 3 and 6.



ACTIVITY 4B

Triangle challenge

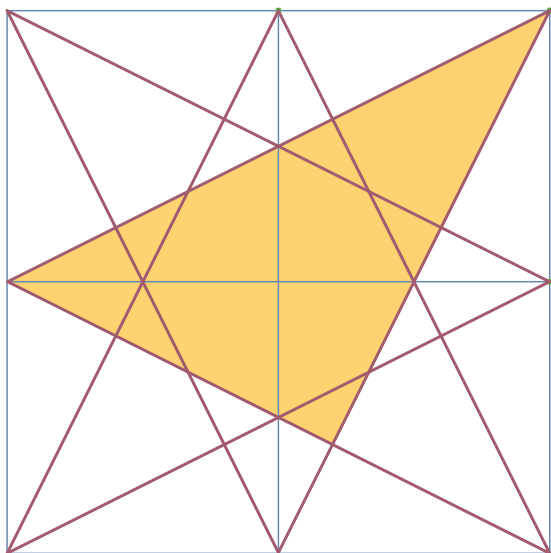
Challenge students to find as many right-angled triangles as possible within the unicursal star they have drawn. Using the triangles highlighted in the diagrams below as examples, they should be able to find 32 in total (don't forget that some of the highlighted triangles can be 'flipped'). This will be quite challenging for some children, so they may benefit from working with a partner.

Before they begin, remind them that a right-angled triangle is a triangle with one angle that measures exactly 90° (this looks like a corner of a square). To provide additional support, you could provide each child or pair of children with something right-angled (the corner of a piece of card would do), which they can place on the diagram to check for right angles.

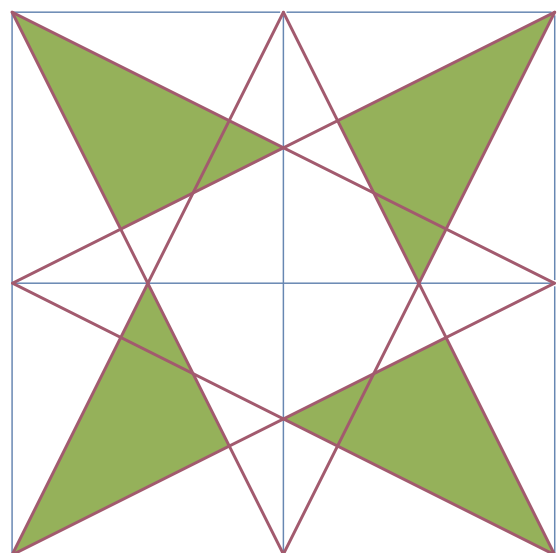


DID YOU KNOW?

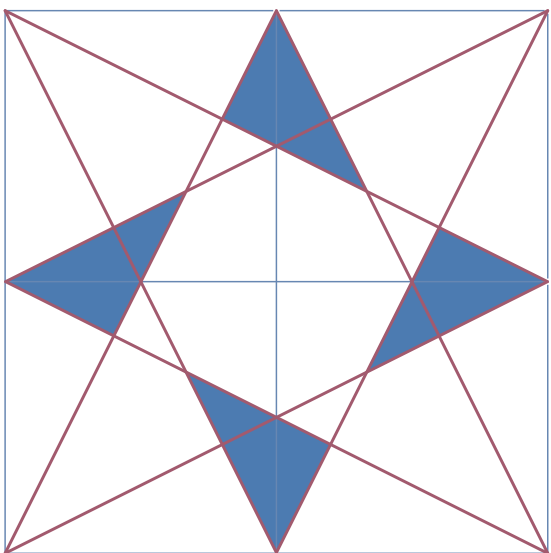
Right-angled triangles are used in many real-life situations. For example, engineers, architects, and carpenters use them to design and build structures. People also use right-angled triangles in sport to work out the distance a ball travels in a game or to calculate the height of a jump, for example.



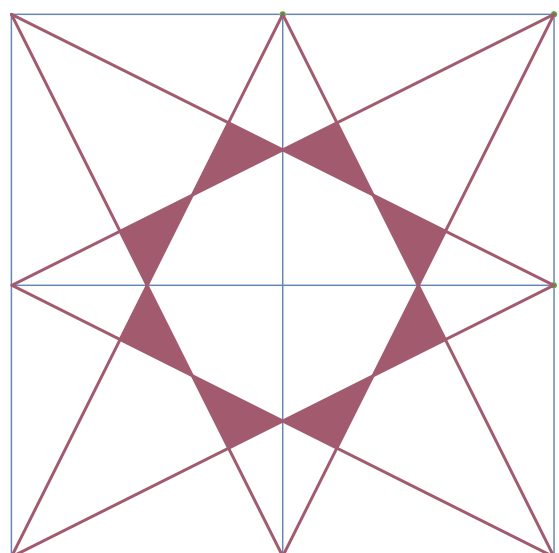
There are eight of these triangles in total.



There are eight of these triangles in total.

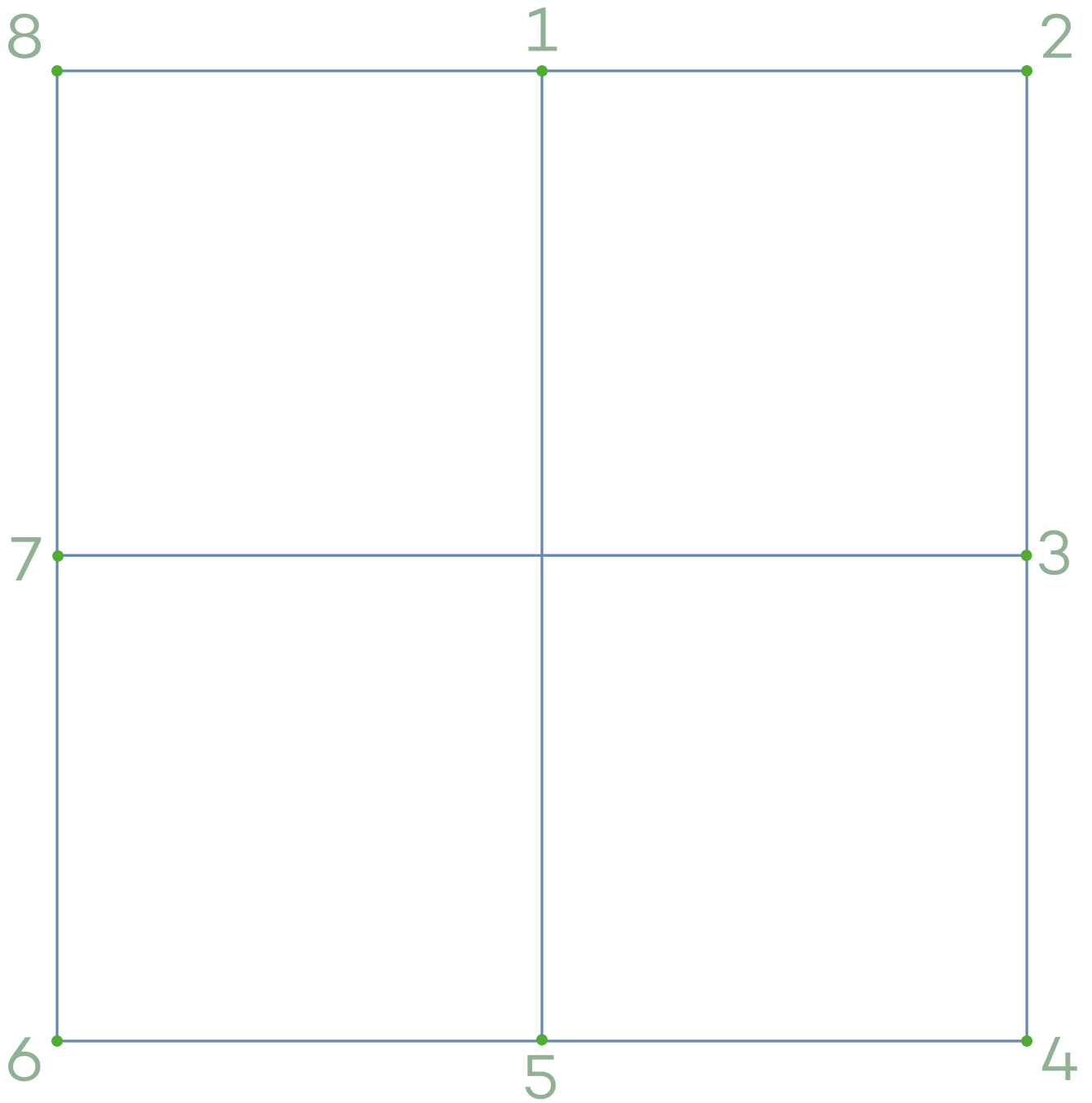


There are eight of these triangles in total.



There are eight of these triangles in total.

PHOTOCOPIABLE RESOURCE 4A



GEOMETRY ACTIVITY 5

ENQUIRY OF LEARNING What can we learn from star patterns?

LEARNING QUESTION What patterns can we make with five-pointed stars?

This activity can be used to support learning about number patterns in maths or as a standalone project.

In this activity, students use a template to draw a series of pentagrams, all of which have their vertices located on the circumference of a circle. When four pentagrams are drawn on one template, a 20-pointed star is created.

A pentagram is a star-shaped figure with five points. It is created by drawing five straight lines connecting the vertices of a regular pentagon (a five-sided shape with equal sides and angles). The pentagram has been significant in many cultures throughout history.

The ancient Greeks admired the pentagram for its mathematical beauty, and it was an important symbol for the Pythagoreans, a group of mathematicians and philosophers who followed the teachings of the Greek mathematician Pythagoras.

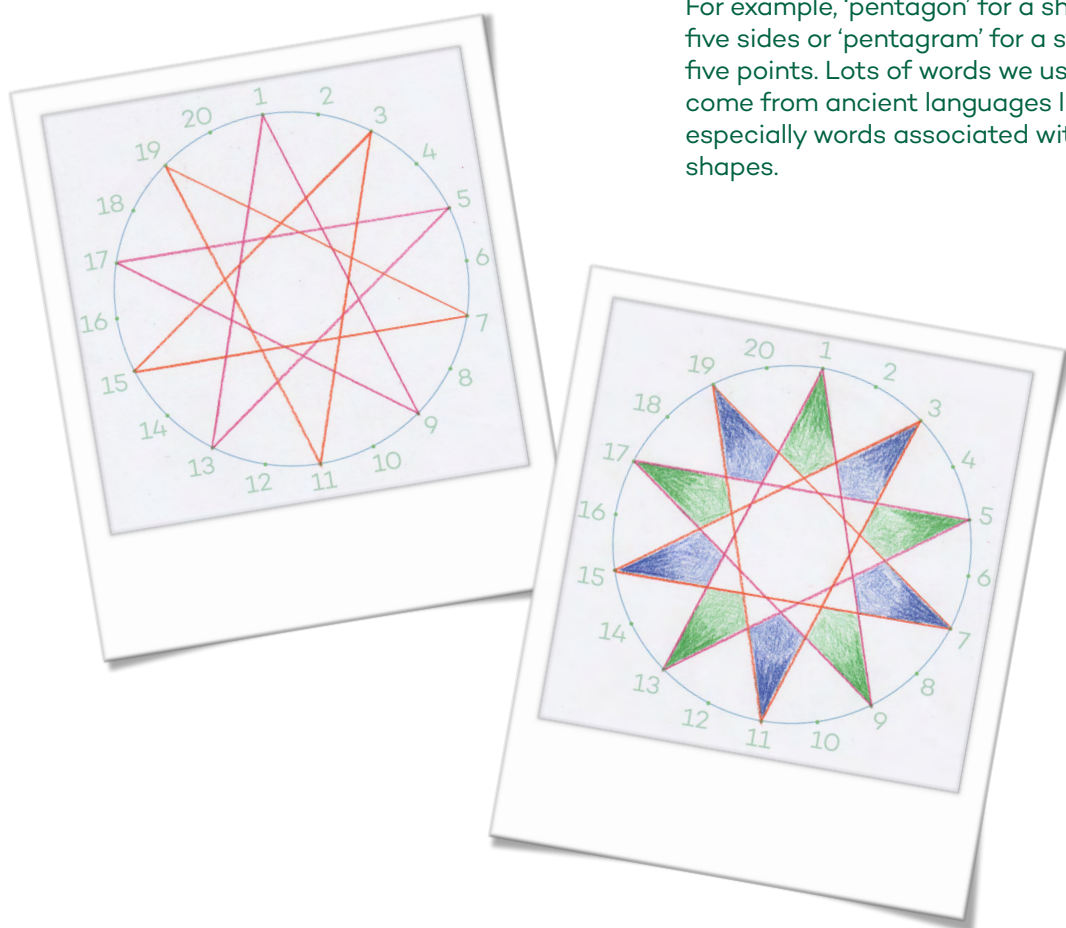
YOU WILL NEED

Copies of Resource 5A
A ruler
An HB pencil
A good-quality eraser
Coloured pencils



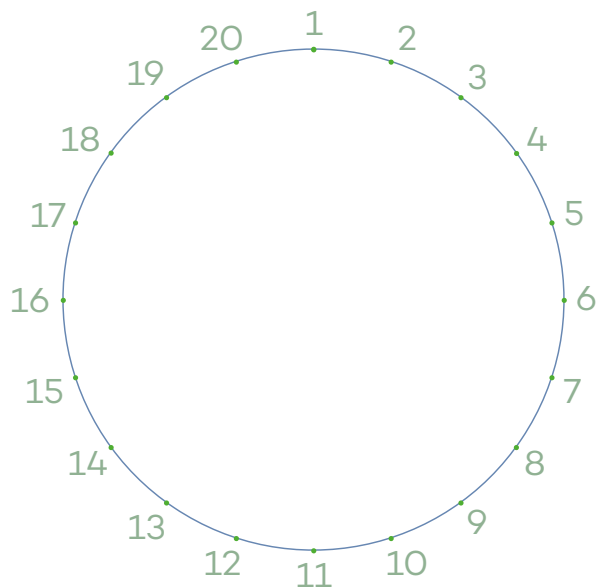
DID YOU KNOW?

The word 'penta' comes from an ancient Greek word meaning 'five'. We use 'penta' in some English words to show that something has a relationship with the number five. For example, 'pentagon' for a shape with five sides or 'pentagram' for a star with five points. Lots of words we use today come from ancient languages like Greek, especially words associated with maths and shapes.



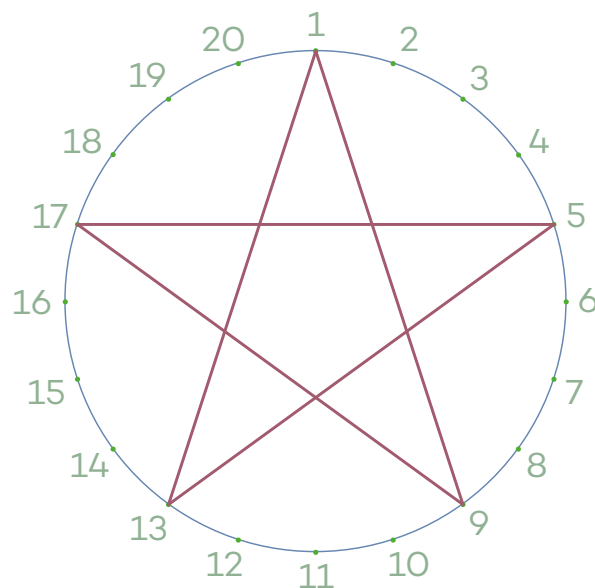
STEP 1 Get to know the 20-point template

Using copies of Resource 5A, take a moment to familiarise yourself with the template.



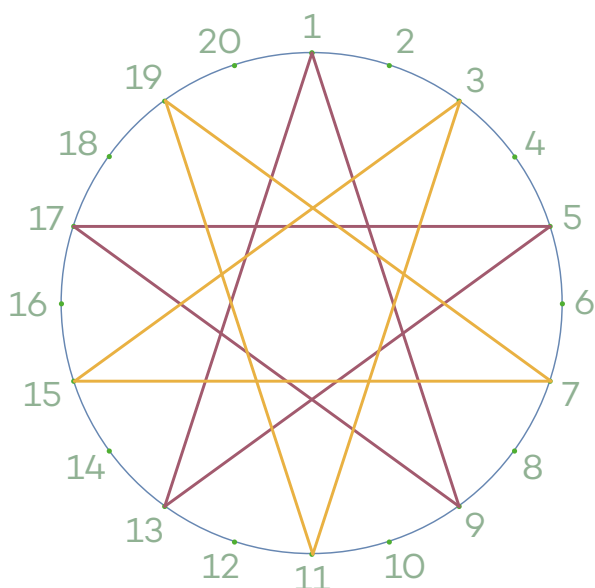
STEP 2 Draw a pentagram

Draw a pentagram on the template by connecting points 1 and 9, 9 and 17, 17 and 5, 5 and 13, and 13 and 1.



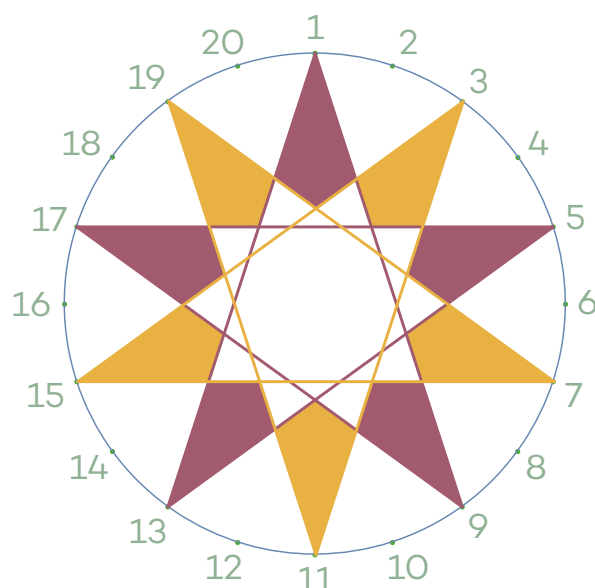
STEP 3 Draw a second pentagram

Draw a second pentagram on the template by connecting points 19 and 7, 7 and 15, 15 and 3, 3 and 11, and 11 and 19. You might want to continue using an HB pencil, or draw each subsequent pentagram in a different colour so you can see more clearly how each is constructed.



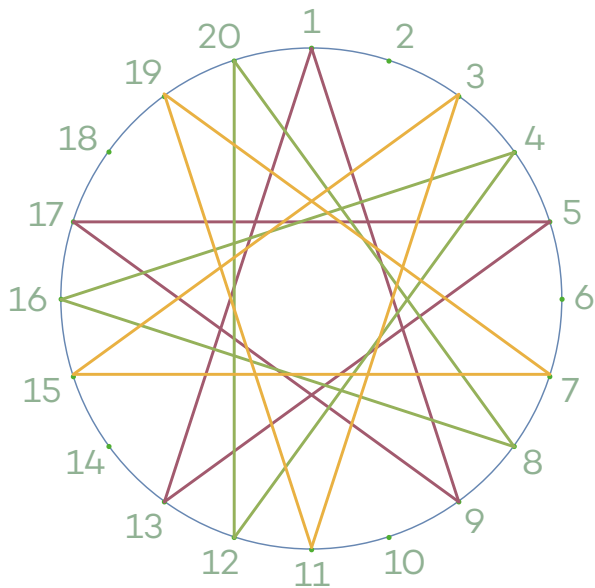
TEACHER TIP

After completing Step 2, students will have drawn a five-pointed star and after Step 3, they will have drawn a 10-pointed star. At either of these stages, they can colour the kite shapes found at each point of the star (see below for an example of a 10-pointed star) to complete the drawing, or continue to the next step.



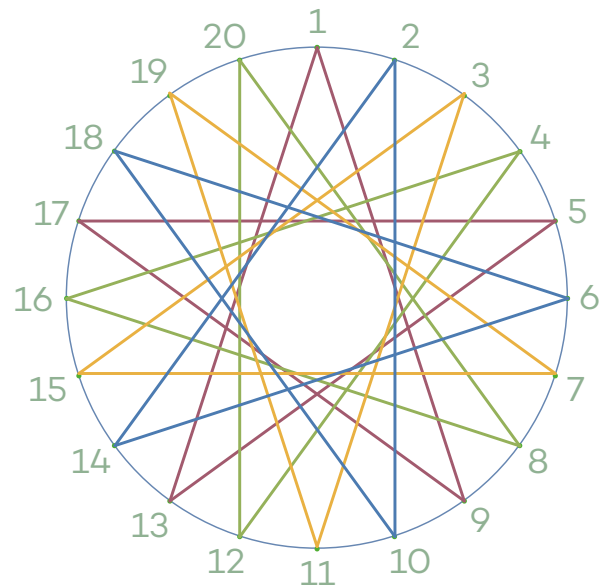
STEP 4 Draw a third pentagram

Draw a third pentagram by joining points 20 and 8, 8 and 16, 16 and 4, 4 and 12, and 12 and 20.



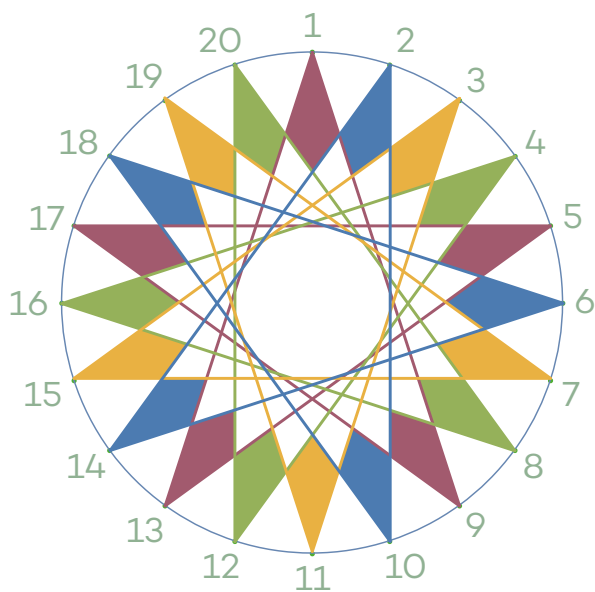
STEP 5 Draw a final pentagram

Draw a fourth pentagram by connecting points 18 and 6, 6 and 14, 14 and 2, 2 and 10, and 10 and 18.



STEP 6 Colour the kite shapes

If you look closely, you will see 20 kite shapes located at the points of the 20-pointed star you have drawn. You could colour these to make the points of the star stand out, as shown below.



TEACHER TIP

This activity provides a fantastic 'jumping off' point for exploring number patterns in maths. You might ask children for example:

What is the sum of the five numbers you used to draw each pentagram?

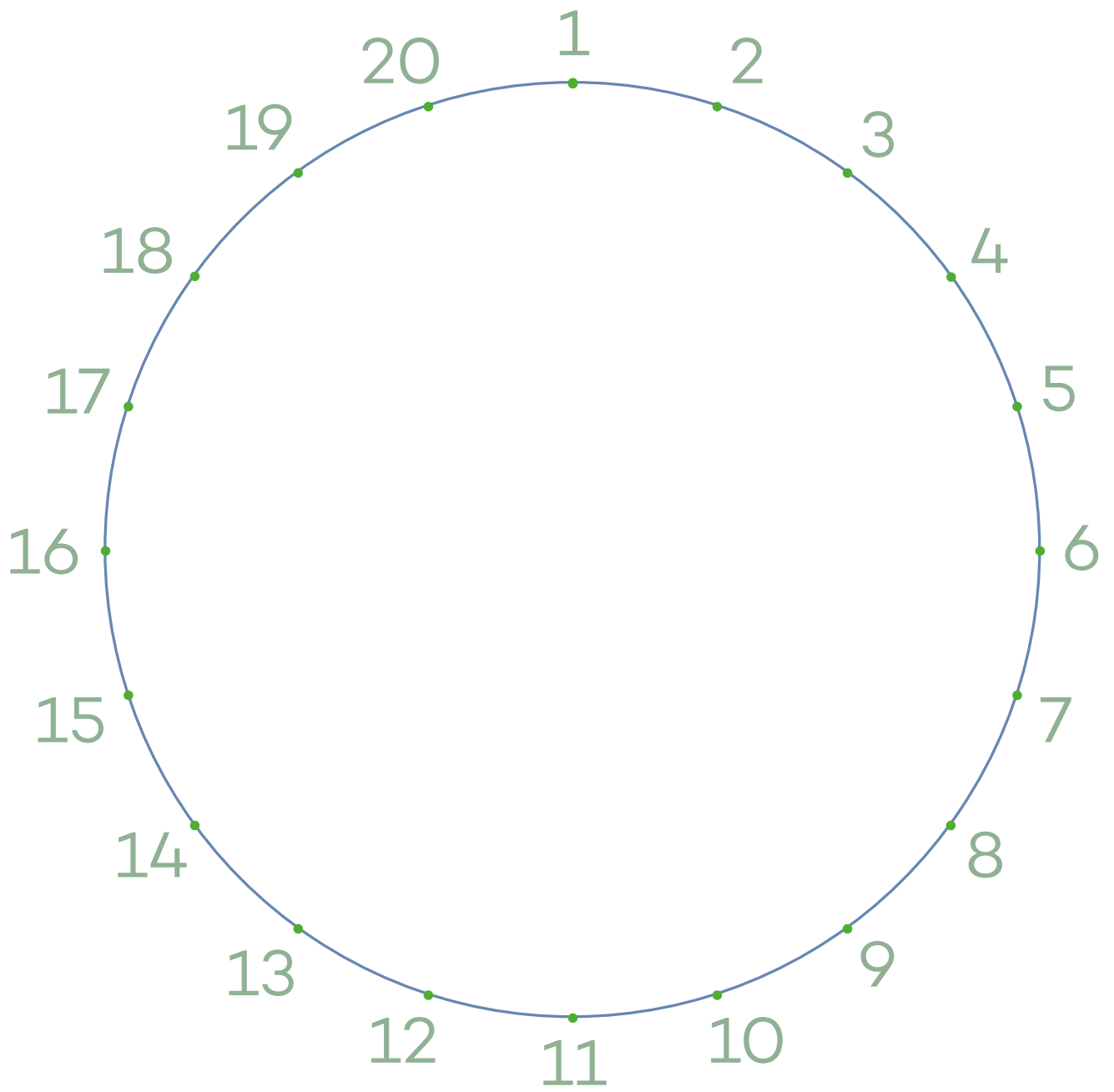
Is there a pattern?

$$1 + 9 + 17 + 5 + 13 = 45$$

$$2 + 10 + 18 + 6 + 14 = ?$$

Can you explain why this pattern occurs?

PHOTOCOPIABLE RESOURCE 5A



GEOMETRY ACTIVITY 6

ENQUIRY OF LEARNING What can we learn from star patterns?

LEARNING QUESTION How can I create a design using pentagrams?

This activity can be used to support learning about shape in maths or as a standalone project.

In this activity, students use a template to draw a pentagram inside a pentagon, then continue adding lines within the pentagon to create other pentagrams.

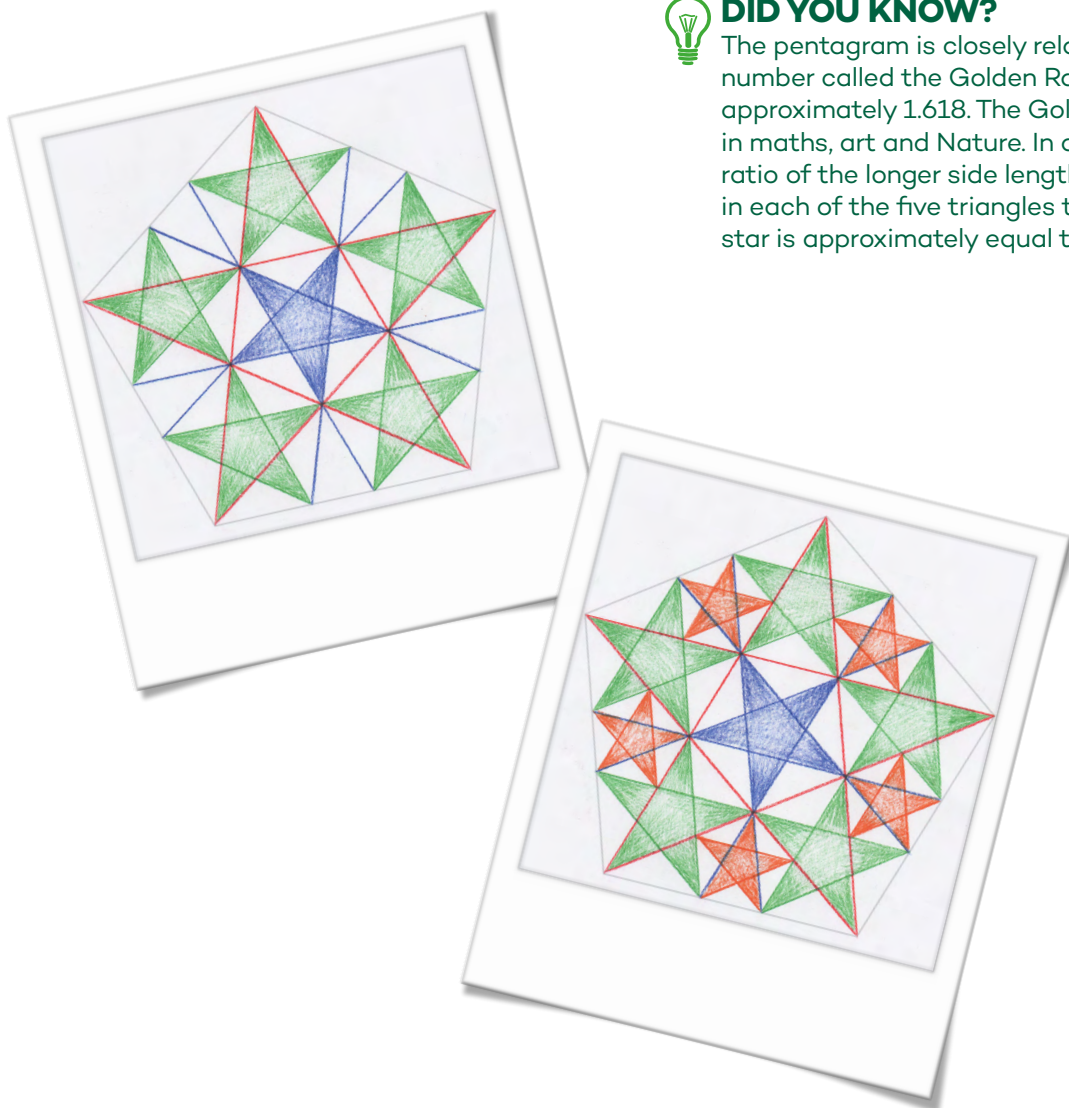
This activity encourages a deeper understanding of the pentagon and pentagram and allows students to recognise the relationships between different shapes. This will help them to recognise patterns and develop spatial awareness, and encourages creativity and problem-solving.

YOU WILL NEED
Copies of Resource 6A
A ruler
An HB pencil
A good-quality eraser
Coloured pencils



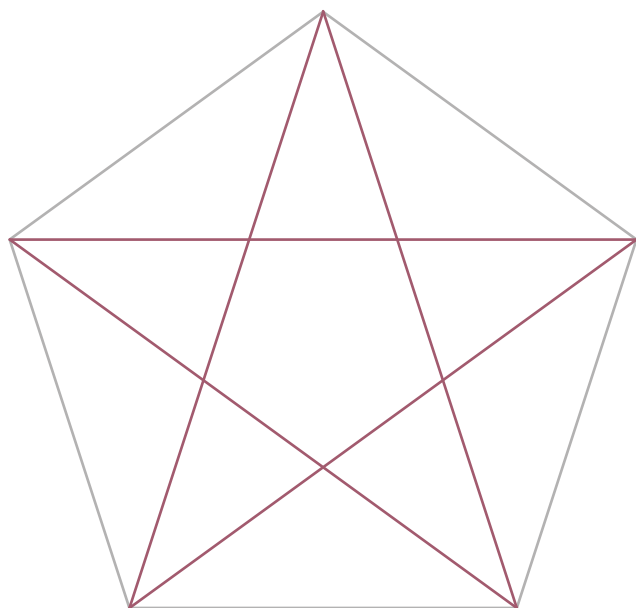
DID YOU KNOW?

The pentagram is closely related to a special number called the Golden Ratio, which is approximately 1.618. The Golden Ratio is found in maths, art and Nature. In a pentagram, the ratio of the longer side length to the shorter one in each of the five triangles that make up the star is approximately equal to the Golden Ratio.



STEP 1 Draw the first pentagram

On copies of Resource 6A, use a ruler to draw two lines from each vertex of the pentagon to the two vertices opposite it.



TEACHER TIP

This activity provides a fantastic 'jumping off' point for revising the properties of shapes. Once students have completed Step 1, ask them:

How many different shapes can you see on the page? How many of each? What are the properties of each?

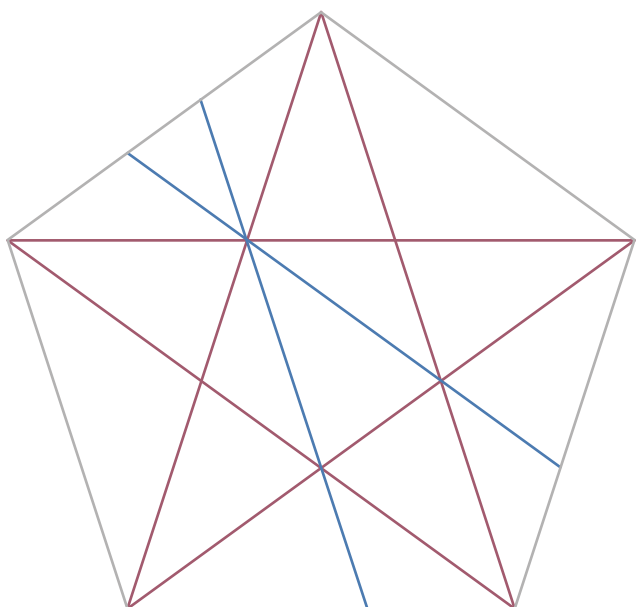
Challenge them to find:

- two pentagons (one small and one large)
- 30 isosceles triangles (five different sizes)
- 10 trapeziums (five small and five large)
- five kites
- five rhombuses

After completing Step 1, draw the students' attention to the small pentagon pointing downwards at the centre of the first pentagram. They will need to locate this to complete Step 2.

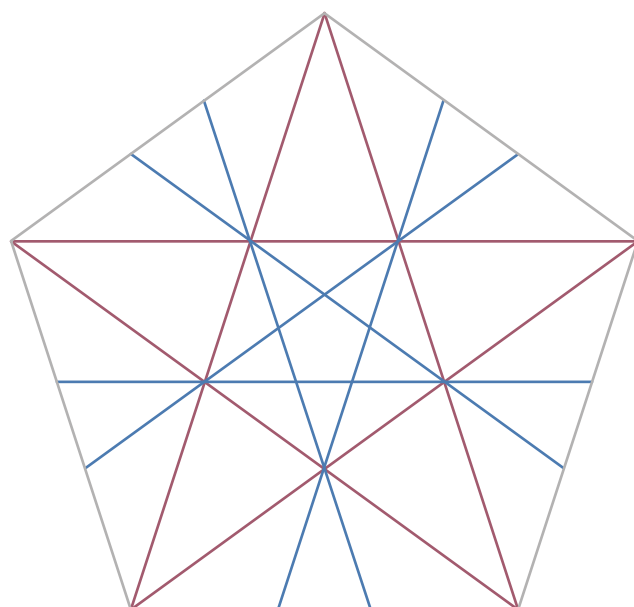
STEP 2 Draw a second pentagram

Inside the pentagram drawn in Step 1, there is a small pentagon pointing downwards. Using the same method outlined in Step 1, draw a smaller pentagram within this pentagon – this time extend each line until it meets two sides of the large pentagon on the template. You will need to draw five lines in total. You could use a coloured pencil for this step if it makes the construction process clearer.



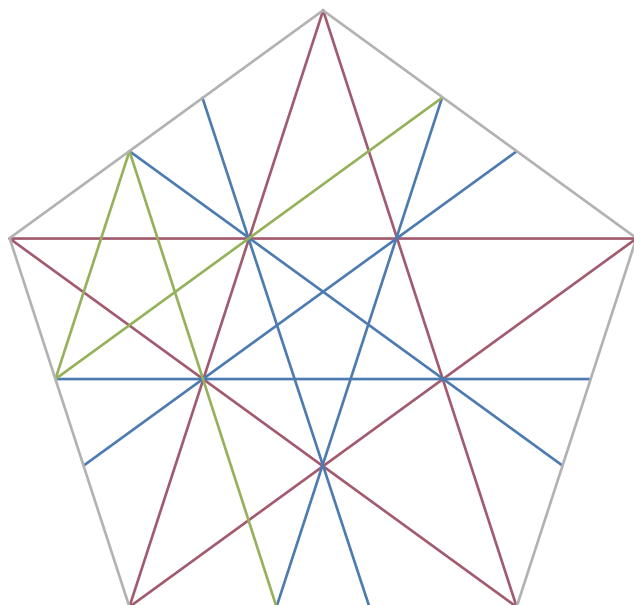
STEP 3 Locate the five new pentagons

Once you have completed Step 2, you will notice that the five lines you have drawn have created five smaller pentagons, one at each vertex of the original, large pentagon on the template. Take a moment to locate them all.



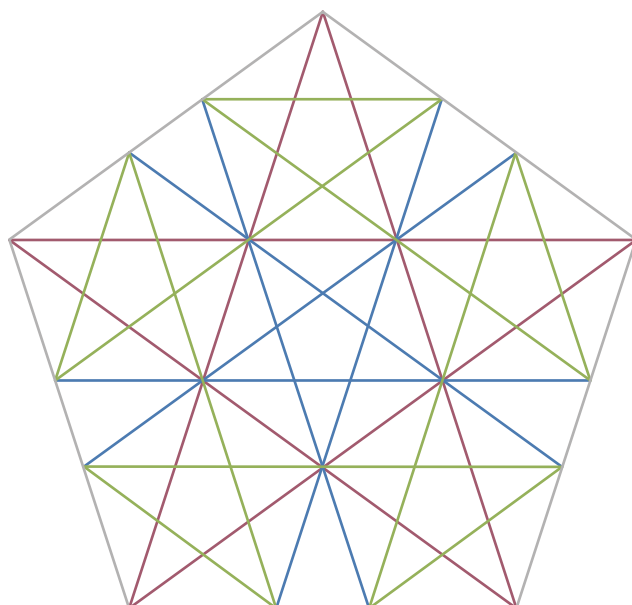
STEP 4 Draw a third pentagram

Using a ruler, connect the vertices of one of the outer pentagons identified in Step 3 to create a third pentagram. You could use a different coloured pencil for this step if it makes the construction process clearer. By extending each line you draw so that both ends touch the sides of the large pentagon, you will start adding lines for other pentagrams.



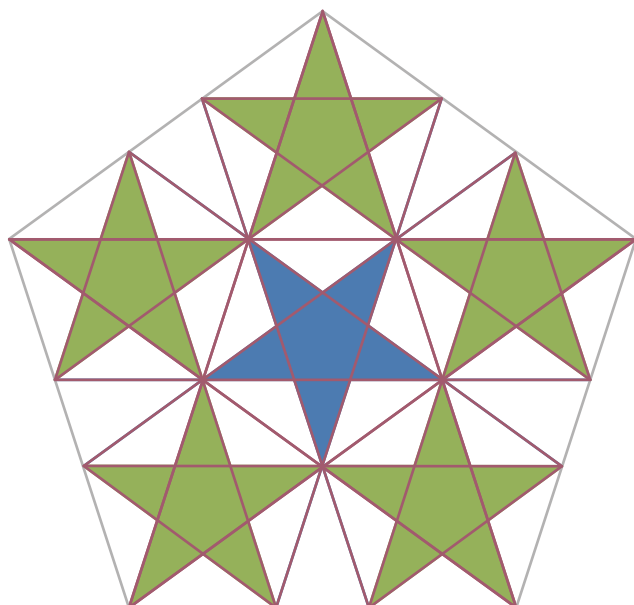
STEP 5 Draw four more pentagrams

Repeat the method outlined in Step 4 to create four more pentagrams, one in each of the smaller, outer pentagons.



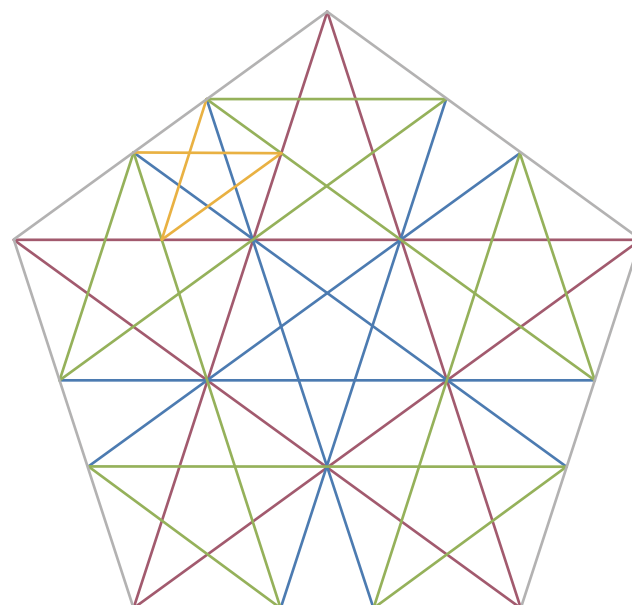
STEP 6 Colour the pentagrams

Use coloured pencil to colour the pentagrams you have created so far. You may wish to stop at this stage, or continue on to complete Steps 7 to 9.



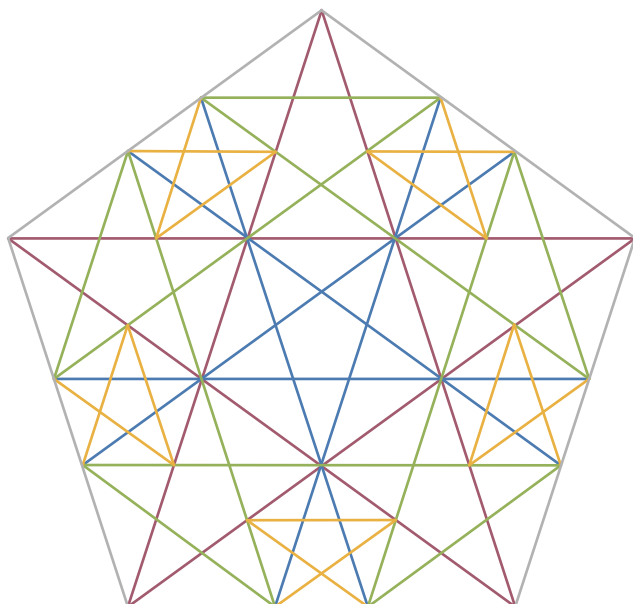
STEP 7 Draw a seventh pentagram

If you look closely, you will notice that the spaces between adjacent stars are also pentagonal. In one of these pentagonal spaces, draw a seventh pentagram by using a ruler to draw lines joining each vertex to the two vertices opposite.



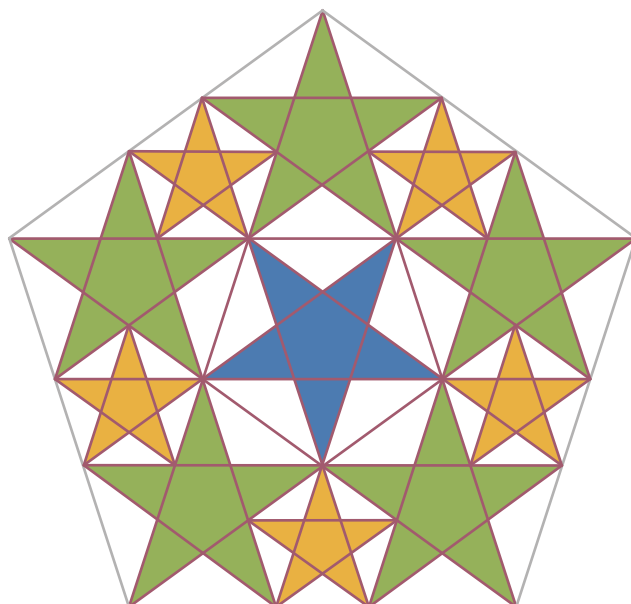
STEP 8 Draw four more small pentagrams

In the four remaining pentagonal spaces between adjacent stars, draw four further pentagrams, using the method outlined in Step 7.



STEP 9 Colour the additional pentagrams

Use coloured pencil to colour the additional pentagrams you have added to the drawing.



PHOTOCOPIABLE RESOURCE 6A

