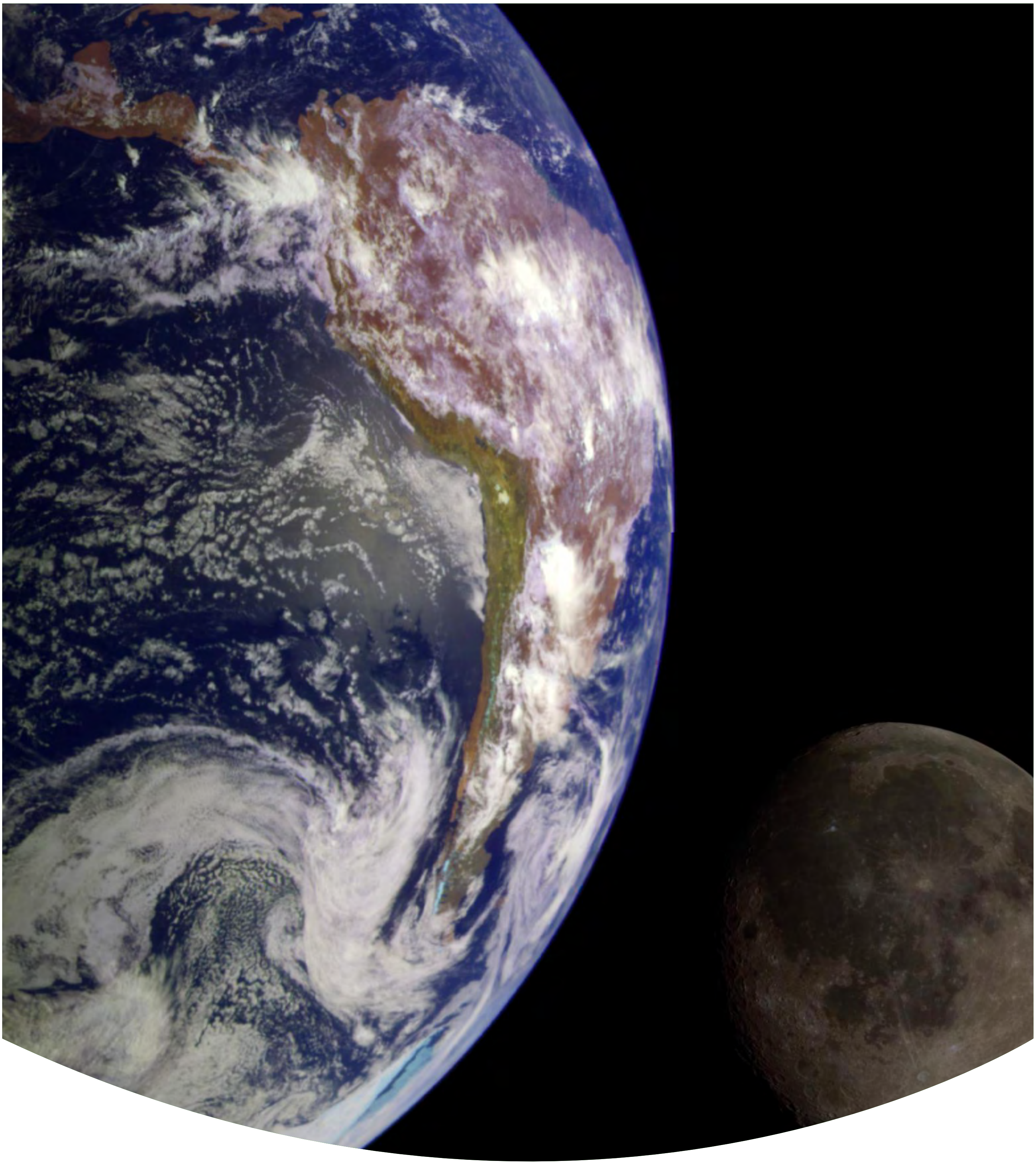


# What are the cycles of our solar system?

## Geometry teaching pack

The Harmony Project

# GEOMETRY ACTIVITIES

## **ENQUIRY OF LEARNING** What are the cycles of our solar system?

The six geometry activities in this pack have been developed to support the Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning, '*What are the cycles of our solar system?*', linked to the principle of the Cycle. In the context of this wider enquiry, each geometry activity introduces the learning each week over the course of a half term by exploring a different pattern or cycle that is a characteristic of our solar system. The complete planning overview for this enquiry of learning can be downloaded from 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 resources that can be used to simplify each activity for students requiring additional support or if you do not have access to compasses for the students to use, or to save time.

## CONTENTS

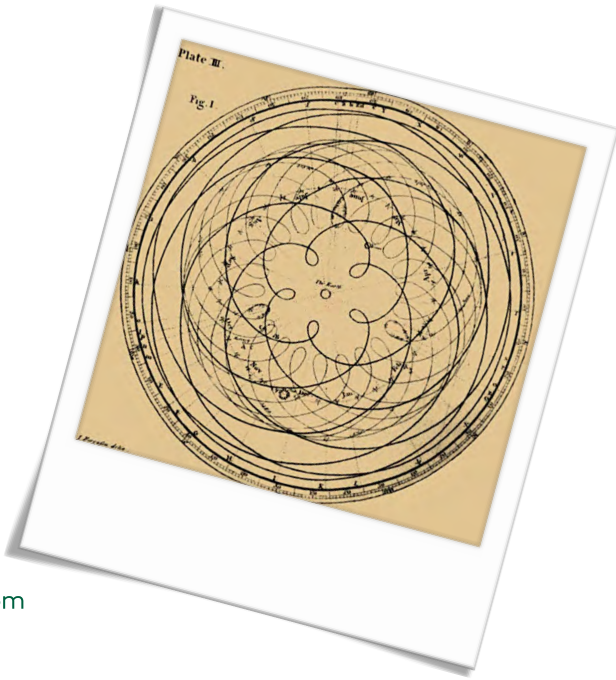


### COMPASSES

The activities in this pack can be adapted so that there is no need to use a compass to complete them. If, however, you wish to invest in compasses to engage in more of the geometric construction, Jakar compasses will help ensure accuracy and are easy to use.

### 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.



The pattern in this etching of the orbit of Venus as viewed from Earth is explored in Activity 6.

# GEOMETRY ACTIVITY 1

## **ENQUIRY OF LEARNING** What are the cycles of our solar system?

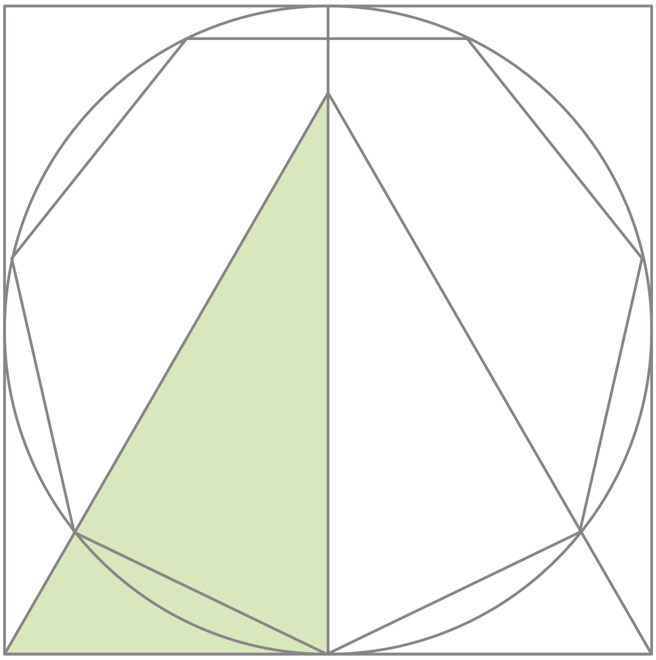
## **LEARNING QUESTION** Why do we have cycles of day and night on Earth?

This activity is part of a Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning about the Solar System, linked to the principle of the Cycle. The wider enquiry allows students to explore the attributes of the solar system and the effect it has on life on Earth.

This activity introduces learning about the cycles of day and night on Earth. We explore this visually with the division of a circle into seven sections using a compass and a ruler. We know that a week is a unit of time made up of seven days. The cycle of the moon is 28 days and its divisors of seven and four give us the number of days in a week and the approximate number of weeks in a month. There are seven days in a week because many centuries ago, people noticed that there were certain patterns in Nature, such as the phases of the moon, that happened roughly every seven days.

### YOU WILL NEED

An HB pencil
A ruler
A good compass
A good-quality eraser
Coloured pencils
Copies of Resource 1A
*Optional: Copies of Resource 1B and/or Resource 1C*

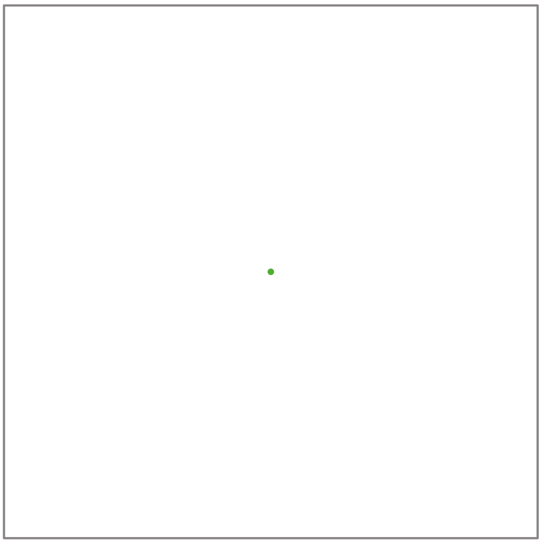


### DID YOU KNOW?

The seven-day week is thought to have originated with the Babylonians, who divided the week into seven days based on the phases of the moon. These days were named after the celestial bodies that were believed to correspond with each day, such as the sun, the moon and the five visible planets. The seven-day week was later adopted by the ancient Romans, who gave each day a name based on the seven celestial bodies. This system was eventually adopted by many other cultures and it continues to be used today.

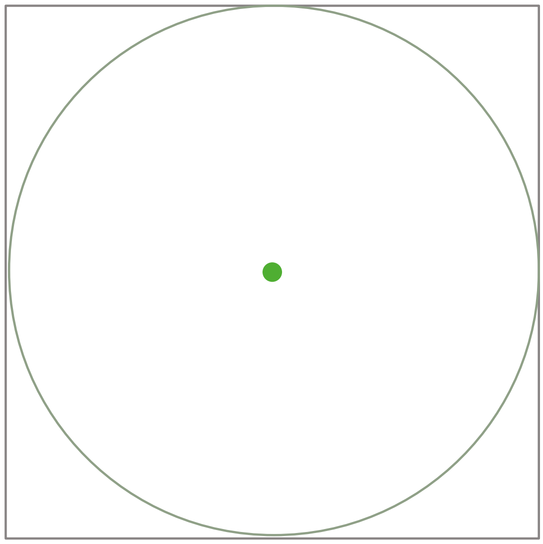
## STEP 1 Familiarise yourself with the square template

The template on p. 7 shows a square with a dot marking its centre point. If you were to draw two diagonal lines joining the opposite vertices of the square, this would be the point at which they cross.



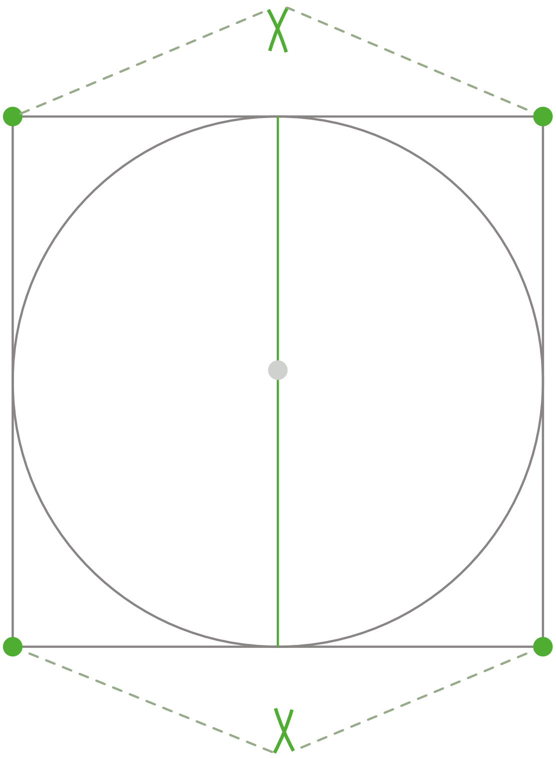
## STEP 2 Draw a circle in the square

Place the point of your compass on the centre point and widen the arms until the pencil point touches every side of the square. Draw a circle.



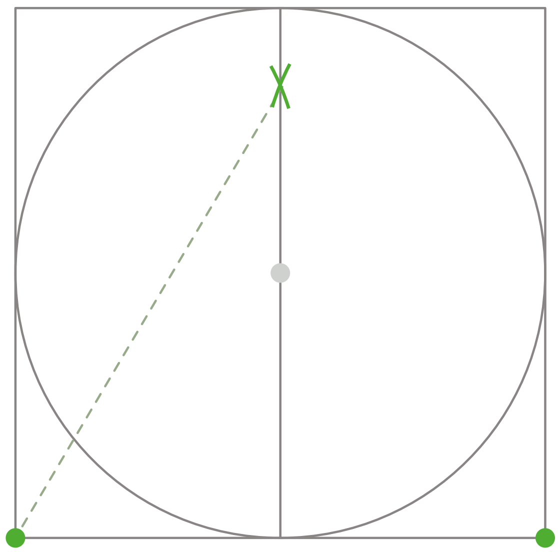
## STEP 3 Bisect the circle vertically

Placing the compass point on the top corners of the square in turn, draw two small arcs roughly over the centre of the square (they should cross). Ensure the compass radius stays the same each time. Repeat with the compass point on the bottom corners. Using a ruler, draw a line connecting the two crosses through the centre point of the circle.



## STEP 4 Set the compass radius to one side length of the square

Extend the arms of the compass so that the distance between the compass point and the pencil point (this is called the radius) is equal to one of the square's side lengths. Place the compass point on the bottom left vertex of the square and draw an arc that intersects the vertical line.

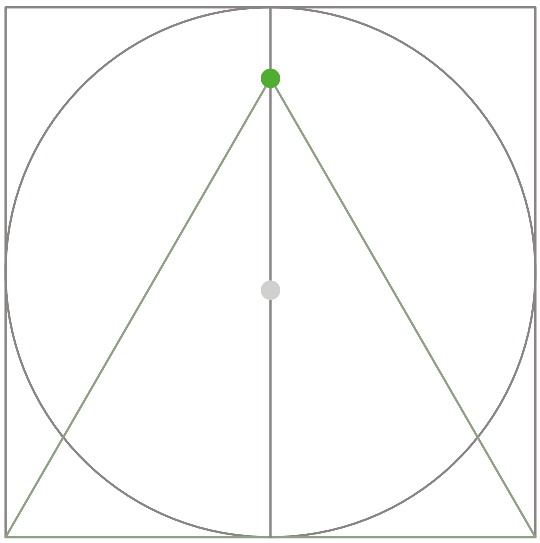


### TEACHER TIP

A good compass makes these activities much easier. However, string or strips of paper and a ruler can be used to allow children to complete some of the stages.

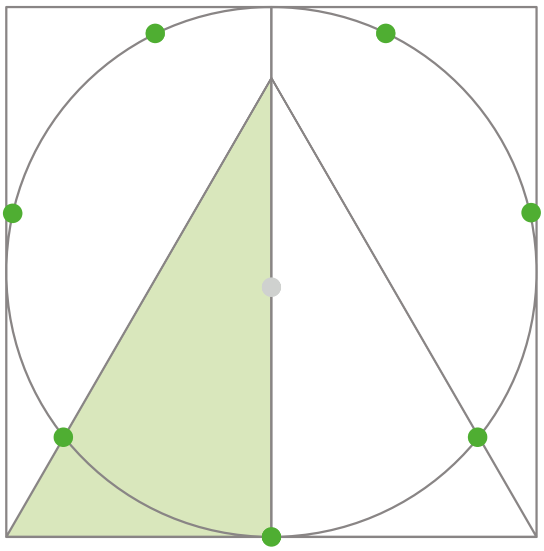
## STEP 5 Draw two diagonal lines

Use a ruler to draw a line connecting the bottom left vertex of the square to the point at which the arc you have just drawn intersects the vertical line (marked with a dot below). Now draw a second line connecting the dot to the bottom right vertex of the square. The two diagonal lines you have just drawn and the bottom side of the square now form the sides of an equilateral triangle.



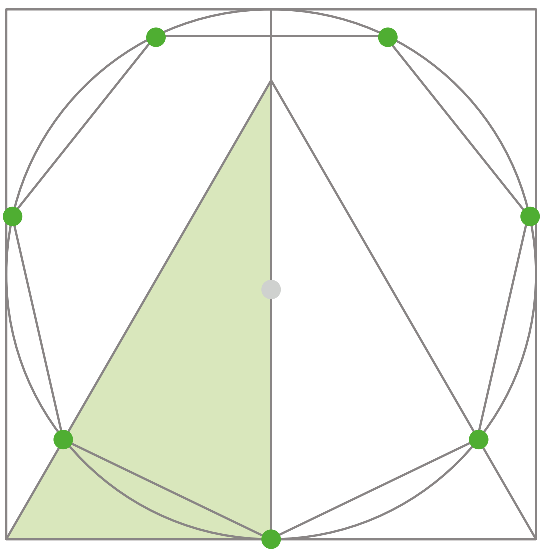
## STEP 6 Mark seven points around the circle with a compass

Place the point of the compass on the point at which the vertical line meets the bottom side of the square. Now place the pencil point of the compass on the point at which the left-hand diagonal side of the triangle intersects the circumference of the circle. Keeping the arms of the compass set this distance apart, place the compass point on the point at which the left-hand diagonal side of the triangle intersects the circumference of the circle and draw a small arc that intersects the circumference. Repeat this, working around the circle until there are seven, equally spaced marks, as shown below.



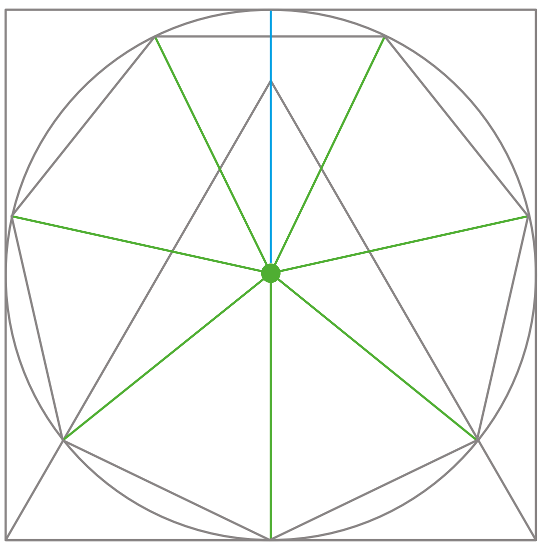
## STEP 7 Connect the points

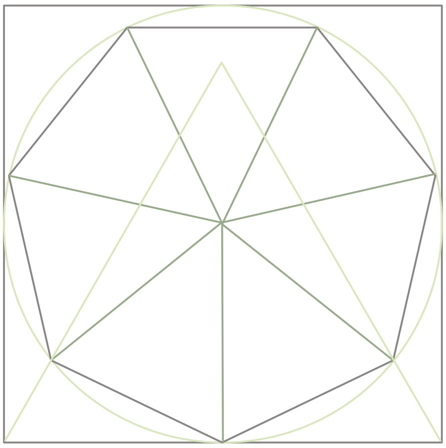
Either working from your own diagram or the tempate provided on the printable resource on page 9, use a ruler to connect the seven points to create the sides of a heptagon. Notice that the relationship between the square (4 sides) and triangle (3 sides) gives you the side length of the heptagon (7 sides).

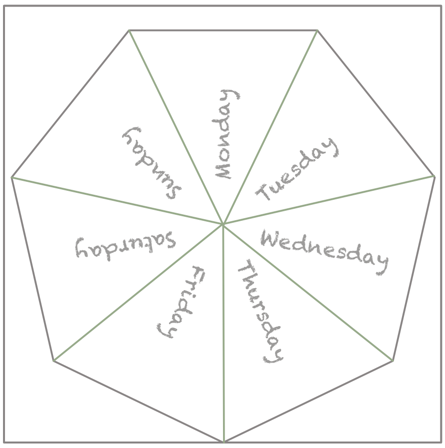


## STEP 8 Divide the circle into segments

Use a ruler to draw seven lines connecting each of the vertices of the heptagon to the centre point of the circle. This will divide the heptagon into seven equal segments. At this stage, you may wish to erase the line marked in blue below to avoid confusion.








## STEP 9 Label and decorate the heptagon

Colour and label each of the seven segments with the name of the week. If you are working with your own diagram, you can lighten the construction lines with an eraser or leave them in place to reveal the process.

## DID YOU KNOW?

**Monday** comes from Old English and means 'moon's day'. This is because the ancient Anglo-Saxons, like many other cultures, named the days of the week after the celestial bodies that they associated with each day. Monday was named after the moon because it was believed that the Moon had a special significance on this day.

**Tuesday** comes from the Old English and Anglo-Saxon name for the god of combat, Tiw, who was associated with the planet Mars.

**Wednesday** comes from 'Woden's day'. Woden was the chief Anglo-Saxon god, and he was associated with the planet Mercury. The planet Mercury was named after this god because it was believed to be the fastest moving planet, and Woden was known for his speed and cunning.

**Thursday** comes from 'Thor's day'. Thor was the god of thunder and war in Norse mythology, and he was associated with the planet Jupiter.

**Friday** comes from the Anglo-Saxon name for the goddess Venus, Frigg, who was associated with love and beauty. The planet Venus was linked to this goddess because it was the brightest object in the sky after the Sun and the Moon.

**Saturday** means 'Saturn's day'. Saturn was the Roman god of time, agriculture and liberation.

**Sunday** means 'sun's day'. Sunday was named after the Sun because it was believed that the sun had a special significance on this day.


## HOW CAN THIS ACTIVITY BE ADAPTED?

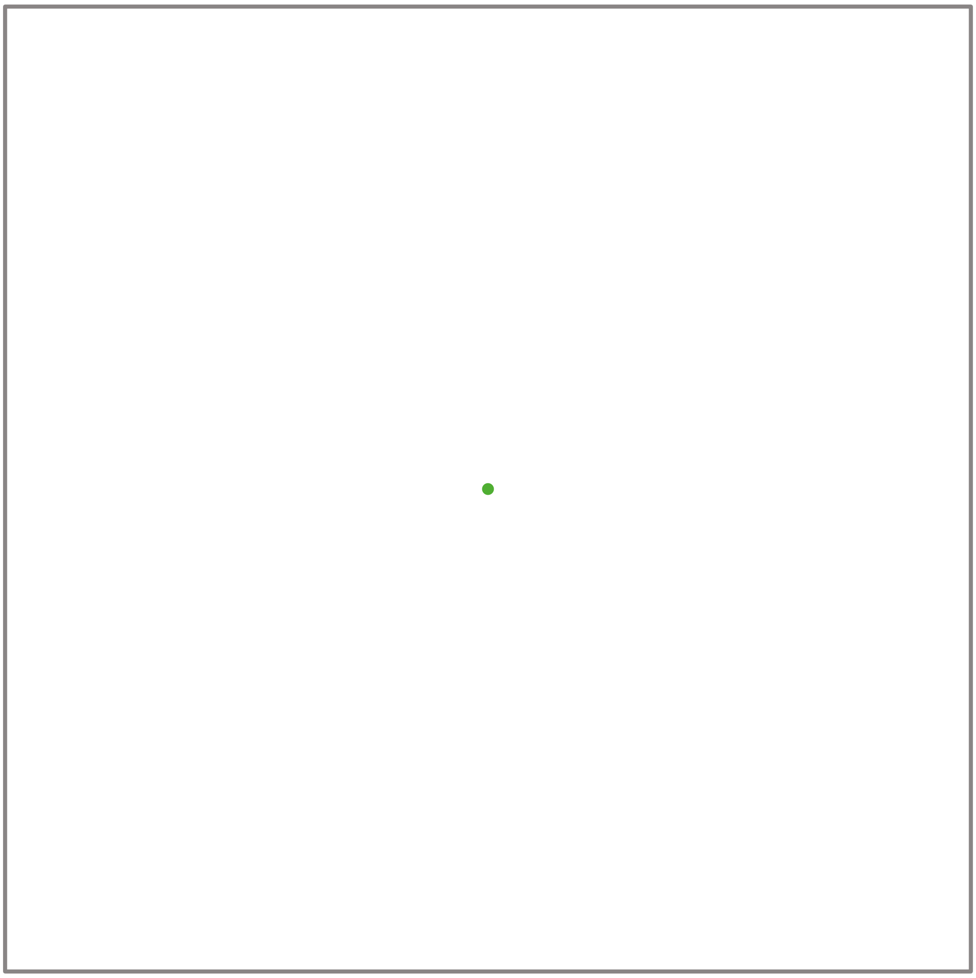
Resources 1B and 1C can be used to provide additional support to students, or if compasses aren't available.

## TEACHER TIP

This activity can be used as a starting point to research the days of the week and the origins of their names and mythology. Students could also find imagery associated with each day of the week.

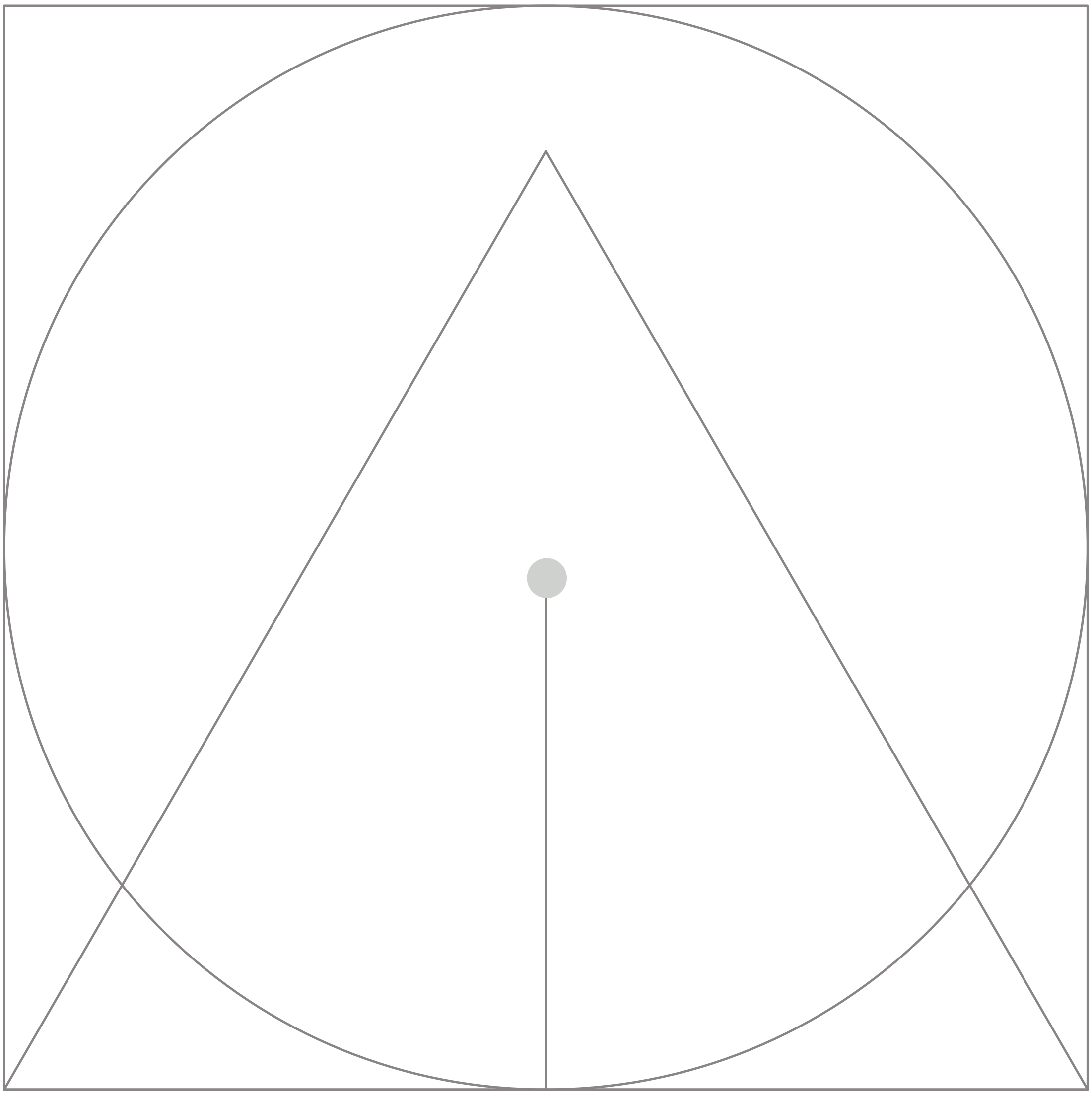
## PHOTOCOPIABLE RESOURCE 1A

Follow Steps 1-9 with a compass and ruler to find your seven-fold division of a circle.



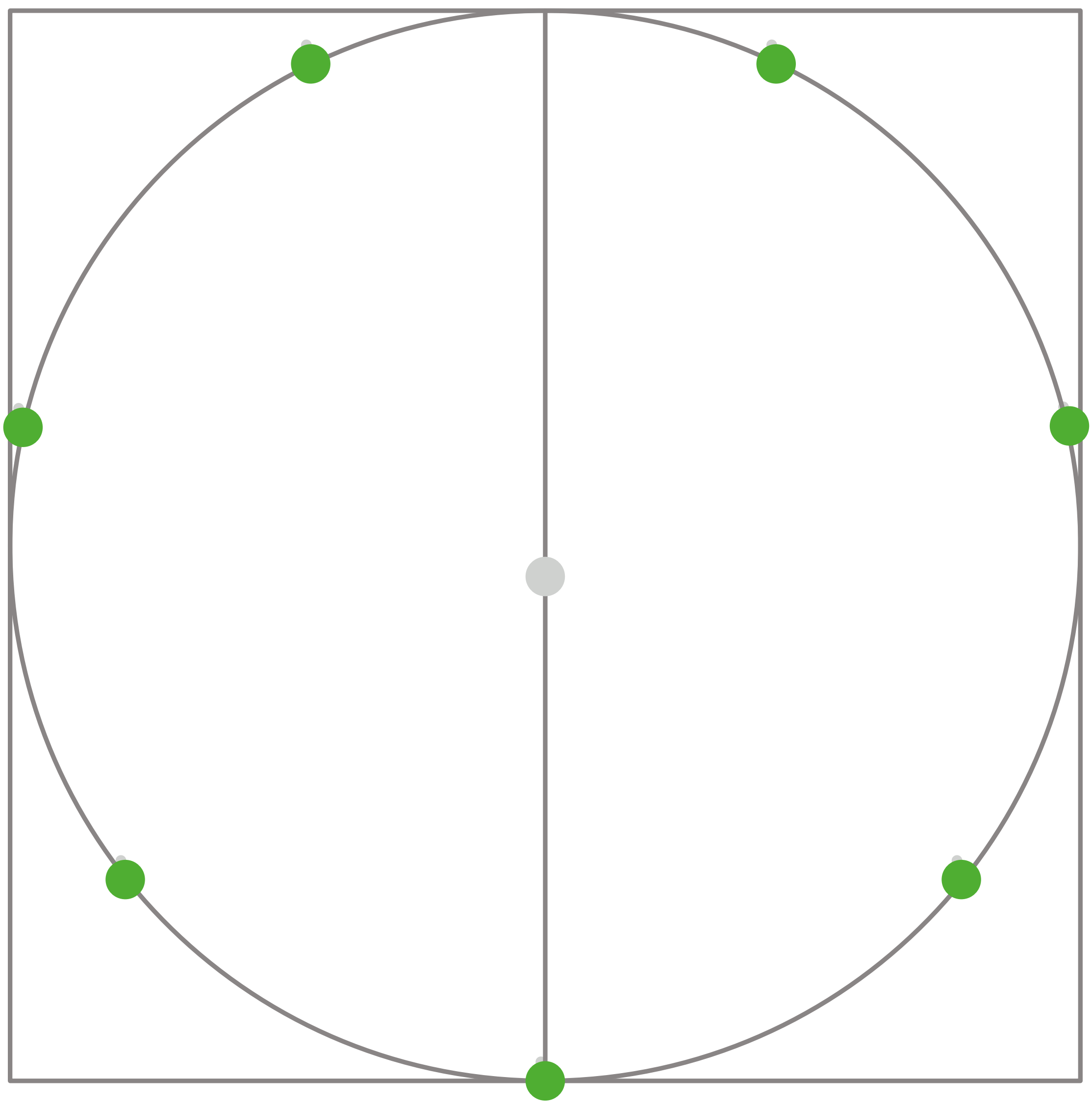
## PHOTOCOPIABLE RESOURCE 1B

To simplify this activity for younger students, or for students who would benefit from additional support, photocopy this resource and follow Steps 6-9.



## PHOTOCOPIABLE RESOURCE 1C

To simplify this activity for younger students, or for students who would benefit from additional support, photocopy this resource and follow the instructions in Steps 7-9.



# GEOMETRY ACTIVITY 2

## ENQUIRY OF LEARNING What are the cycles of our solar system?

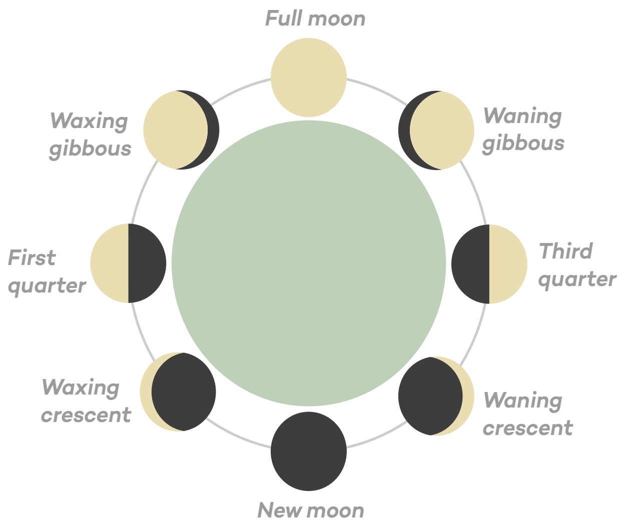
## LEARNING QUESTION What are the phases of the moon?

This activity is part of a Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning about the solar system, linked to the principle of the Cycle. The wider enquiry allows students to explore the attributes of the solar system and the effect it has on life on Earth.

This activity uses eight-fold symmetry to visualise the phases of the moon. There are eight moon phases, distinct appearances that the moon has as it orbits the Earth. The most common names for the eight moon phases are shown in the diagram below. These names refer to the shape of the moon as it appears in the sky, and they describe the way that the illuminated portion of the moon changes over time. For example, a new moon is the phase where the moon is not visible because it is located between the Earth and the sun, and a waxing crescent is the phase where the moon appears as a thin crescent shape, with the crescent getting larger each night.

### YOU WILL NEED

An HB pencil
A ruler
A good compass
A good-quality eraser
Coloured pencils
*Optional: Copies of Resource 2A Resource 2B and/or Resource 2C*

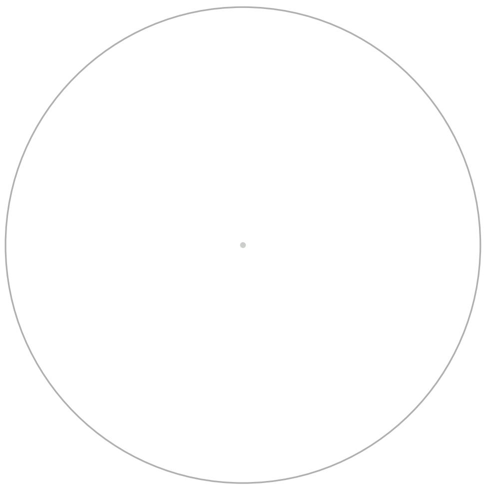



### DID YOU KNOW?

The moon's gravity causes the oceans on Earth to 'bulge out' in two places. When the bulges are closest to the shore, we have high tides. When the bulges are farthest from the shore, we have low tides.

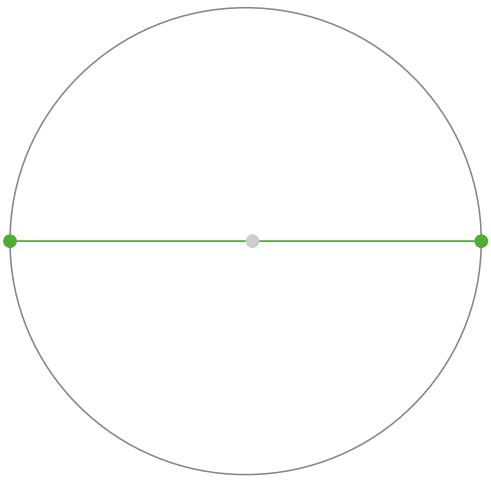
## STEP 1 Draw a circle

Mark a central point on the page. Set the arms of a compass so that the compass point and the pencil point are 7.4cm apart. Place the compass point on the central point of the page and draw a circle.



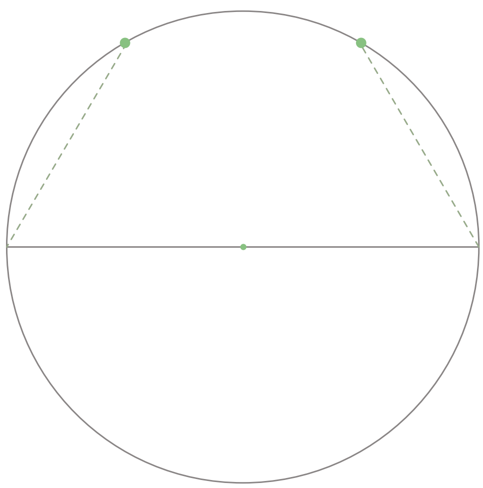
## STEP 2 Divide the circle horizontally

Use a ruler to draw a horizontal line that joins two opposite points on the circumference of the circle, passing through the centre point. This line marks the circle's diameter. The rest of the drawing will be built up relative to this line.



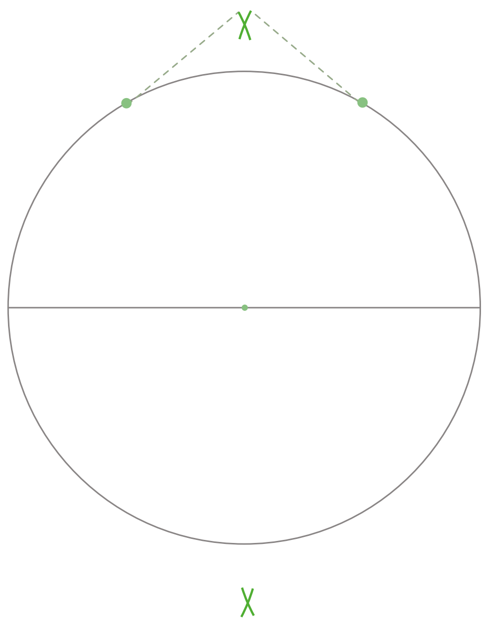
## STEP 3 Find the vertical bisector (1)

You now need to find the position of the vertical line that bisects the horizontal line at a right angle. Using a standard compass, this is a two-step process on such a large circle. Place the compass point at one of the points where the horizontal line meets the circumference of the circle. Use the compass to mark a point on the circumference of the circle. Without changing the distance between the arms of the compass, repeat this from the point where the other end of the horizontal line meets the circumference of the circle.



## STEP 4 Find the vertical bisector (2)

Set the distance between the compass point and the pencil point to 4cm. Placing the compass point at each of the two points marked in Step 3 in turn, draw a small arc above the centre point of the circle. The two arcs should cross. Repeat the process outlined in Steps 3 and 4 in the lower half of the circle. Use a ruler to draw a vertical line between the two crosses made by the arcs.

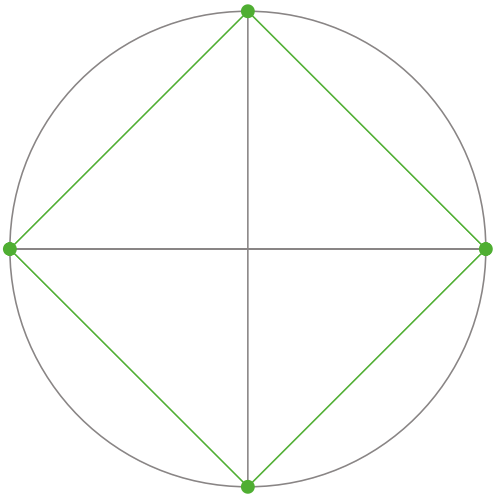


### TEACHER TIP

A good compass makes these activities much easier to follow. If compasses aren't available, string, strips of paper and a ruler can be used with the photocopiable resources provided.

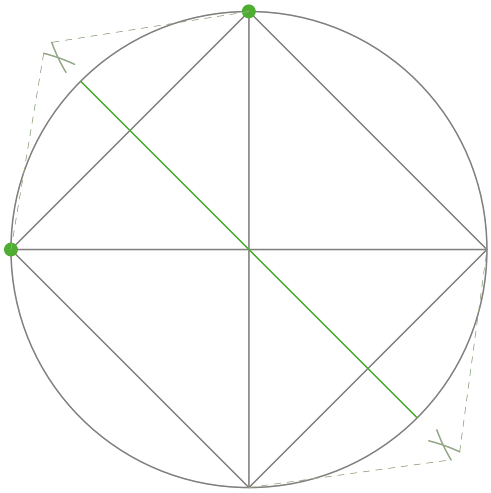
## STEP 5 Draw a dynamic square

The four, equally spaced intersections around the circumference of the circle can be used to create the outline of a square resting on its point. Draw this square using a ruler. A square resting on its point, rather than a flat edge, is known as a dynamic square.



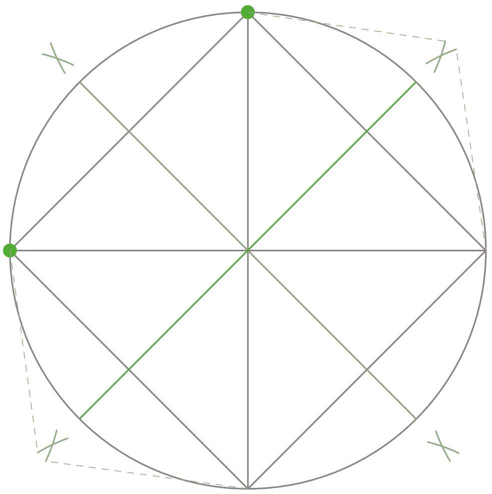
## STEP 6 Find the diagonals using bisection

Place the point of the compass on one of the vertices of the square. Adjust the compass arms so that the compass point and the pencil point are roughly 7cm apart. Draw an arc over the mid-point of one side of the square. You will need to do this at both points marked with a green dot below in order to make a small cross that marks the midpoint. Repeat this on the opposite side of the square.



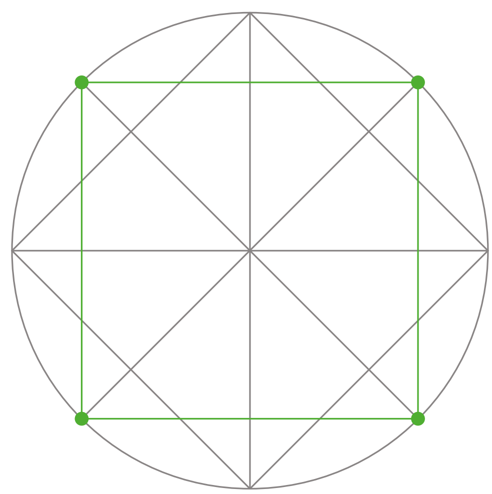
## STEP 7 Bisect every side

Repeat the process from Step 6 on the remaining sides of the square. You should now have four crosses that mark the diagonals of the drawing. Draw two lines that connect the crosses opposite each other using a ruler, as shown below.



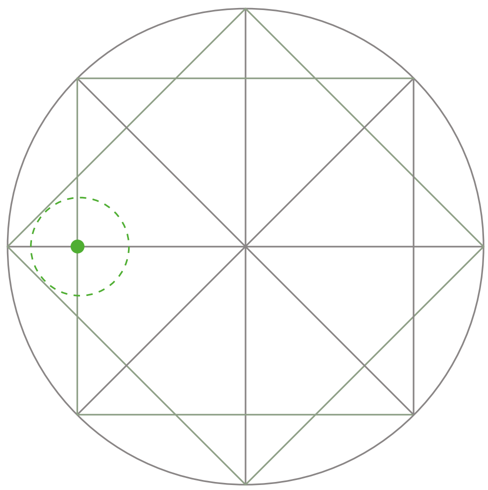
## STEP 8 Draw a static square

Using a ruler, draw four lines that connect the points at which the diagonals meet the circumference of the circle to form another square. This is called a 'static square', a square resting on its side. The two overlaid squares should create an eight-pointed star. The points of the star mark eight equidistant points around the circumference of the circle.



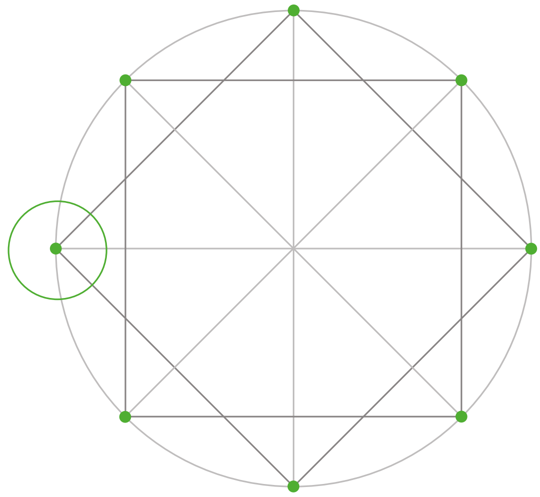
## STEP 9 Set the compass to draw the moon

Place the point of the compass at the intersection marked with a green dot below. Adjust the arms so that the pencil point touches the sides of the dynamic square as shown. You are now ready to complete the next step.



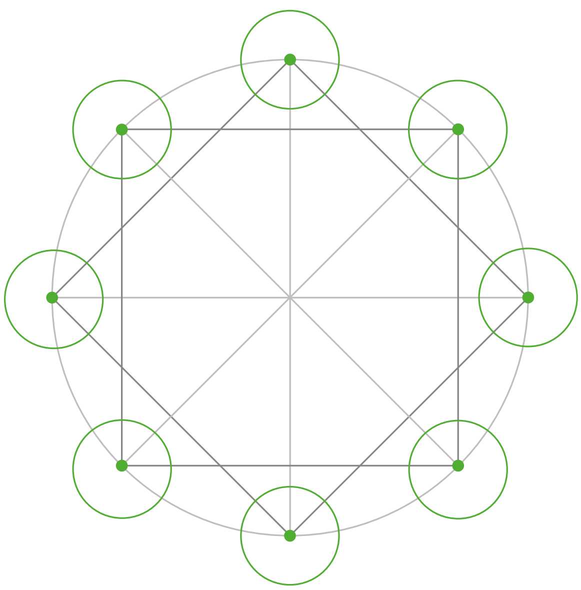
## STEP 10 Draw a circle representing the moon

Using the measurement from Step 9 (the distance between the point and the pencil point of the compass should be 1.5cm), use the compass to draw a circle representing the moon at one point of the eight-pointed star, as shown below.



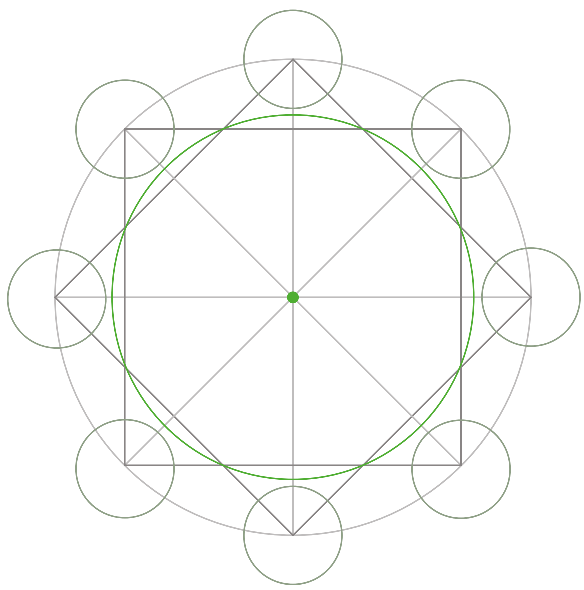
## STEP 11 Draw a moon at every point

Draw seven further moon circles at the remaining points of the eight-pointed star, taking care each time to check your compass has remained accurate and kept the right measurement.



## STEP 12 Find the Earth circle

The Earth in this diagram is proportional to the moon, which is an 11:3 ratio. Amazingly, you can find the correct dimensions of the Earth (with an 11cm diameter) within the diagram by drawing a circle that touches the internal octagon shown below.
To do this, place the point of the compass on the midpoint of the diagram and adjust the arms until the pencil point touches the points where the sides of the two squares intersect, as shown below.



### DID YOU KNOW?

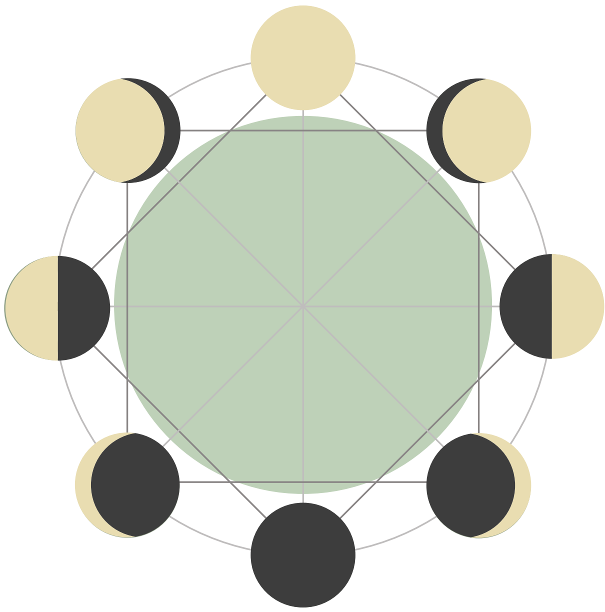
The moon's orbit around the Earth causes it to pass occasionally in front of the sun. When this happens, we experience a solar eclipse on Earth. When the moon passes behind the Earth, it causes a lunar eclipse.

### TOP TIP

Before you complete the next steps, you may want to erase any construction lines or use tracing paper to transfer the diagram onto a fresh sheet for shading and colouring.

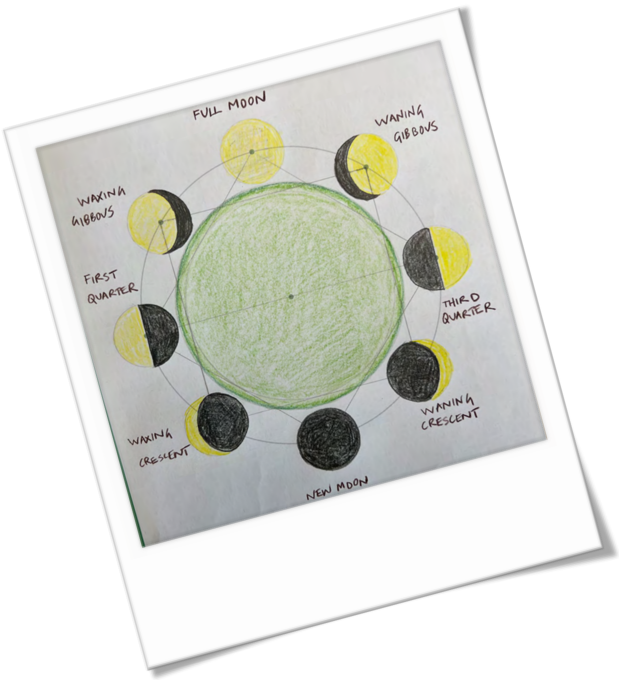
## STEP 13 Shade the eight moon phases

Shade the eight circles around the diagram according to the eight moon phases shown and named in the list, right. You can use a ruler and compass to help you estimate and outline the crescent and quarter phases. Start with the new moon at the bottom and work clockwise.



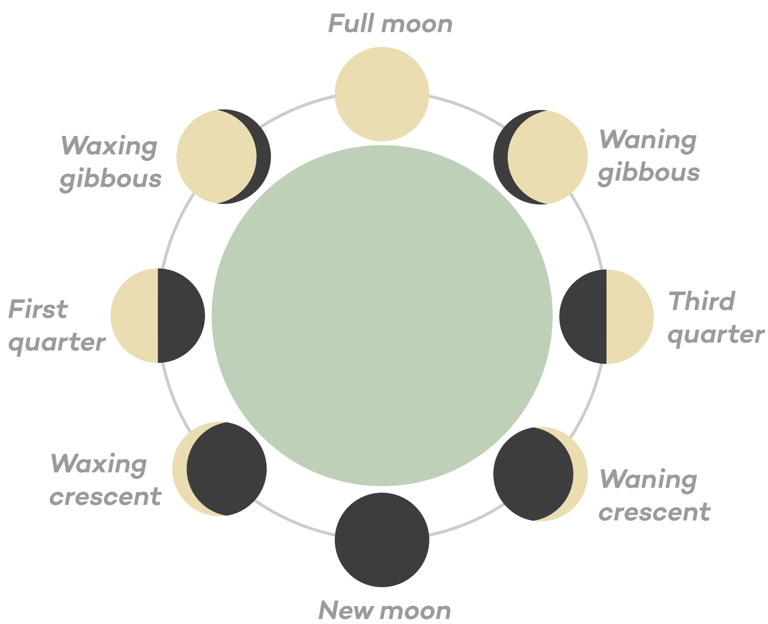

### DID YOU KNOW?

The moon's rotation around its own axis takes the same time as its orbit around the Earth. This means the same side of the moon always faces the Earth.



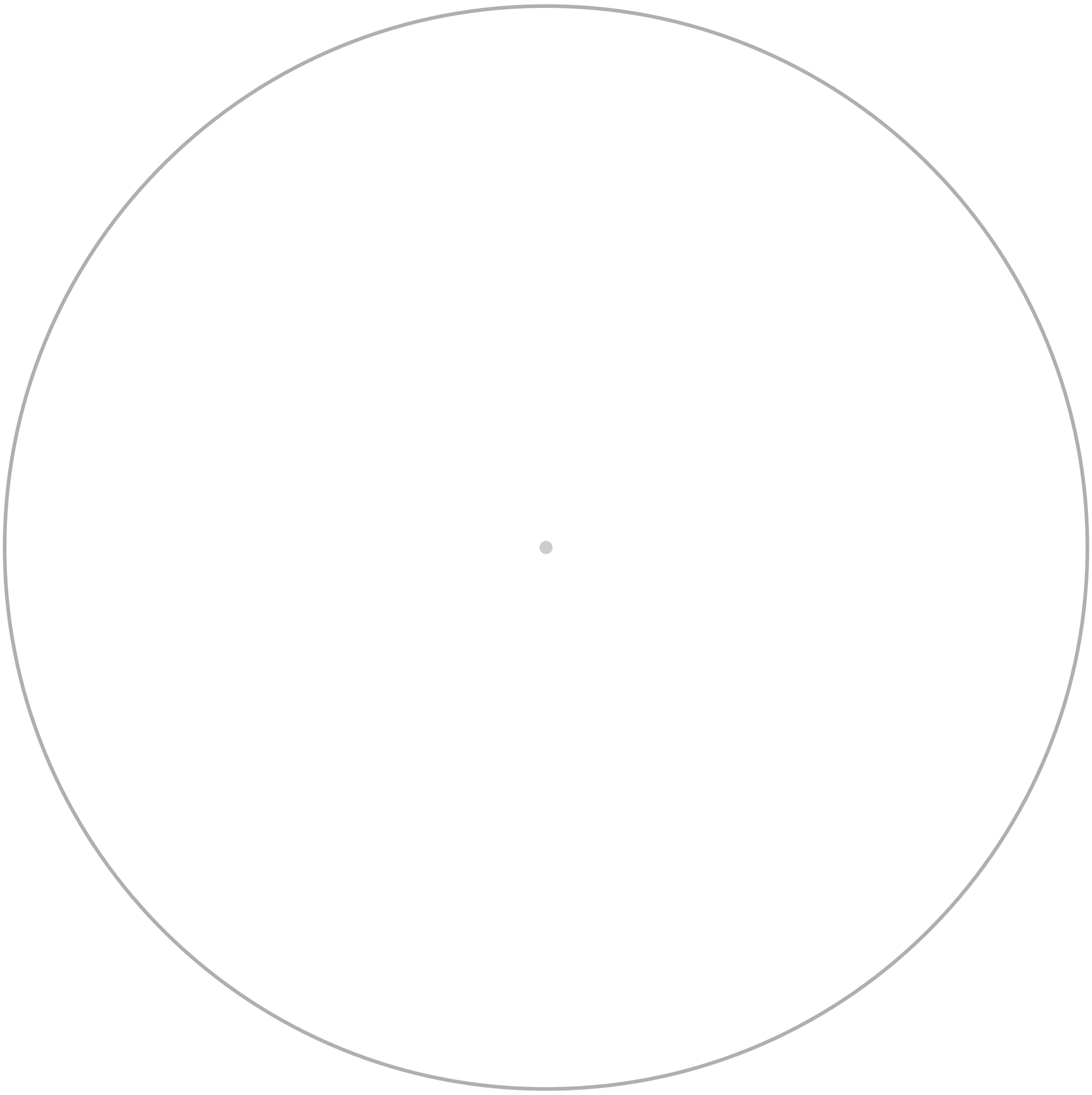

## STEP 14 Shade the Earth circle and label the moon phases

Shade the Earth circle on the diagram and add labels to show the name of each phase of the moon.



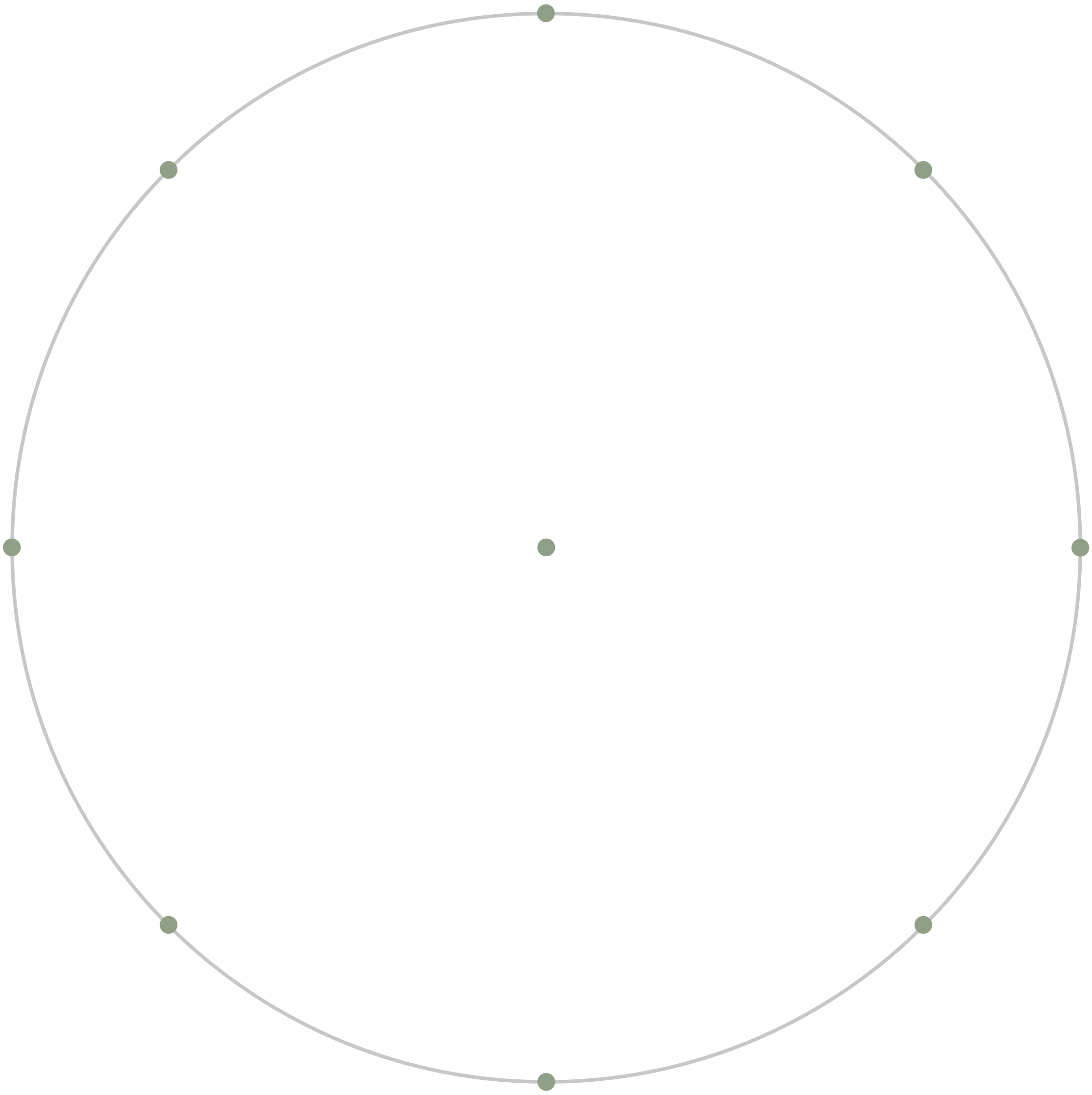
## PHOTOCOPIABLE RESOURCE 2A

Follow Steps 1-14 with a compass and ruler to create an eight-pointed star and create the moon phases diagram.



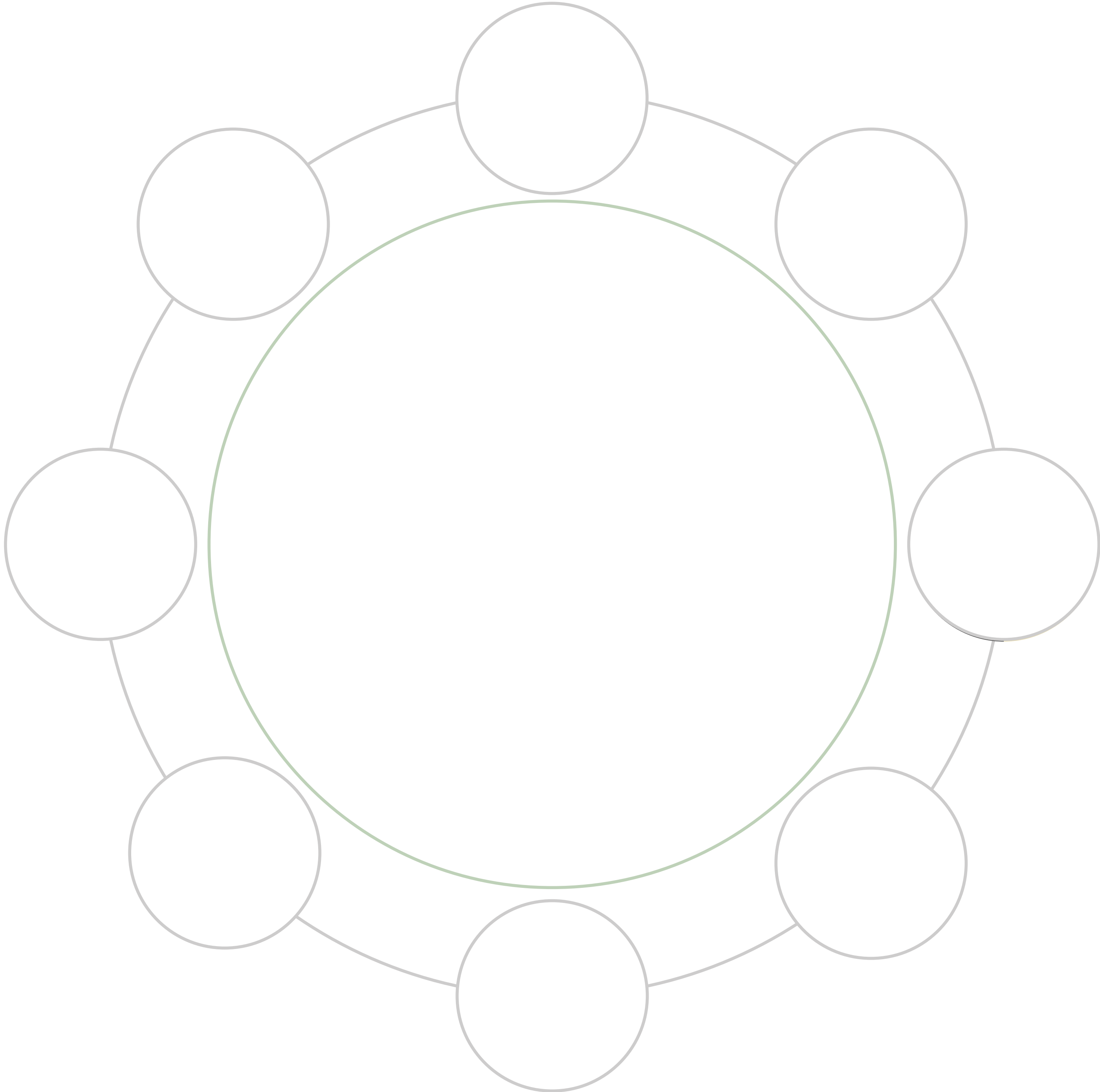
## PHOTOCOPIABLE RESOURCE 2B

Complete Step 5 then Steps 8-14 to create an eight-pointed star and the moon phases diagram.



## PHOTOCOPIABLE RESOURCE 2C

To simplify this activity for younger students, or for students who would benefit from additional support, photocopy this resource to complete the final steps of the activity by shading and labelling the moon phases and shading the Earth (Steps 13 and 14).



# GEOMETRY ACTIVITY 3

**ENQUIRY OF LEARNING** What are the cycles of our solar system?

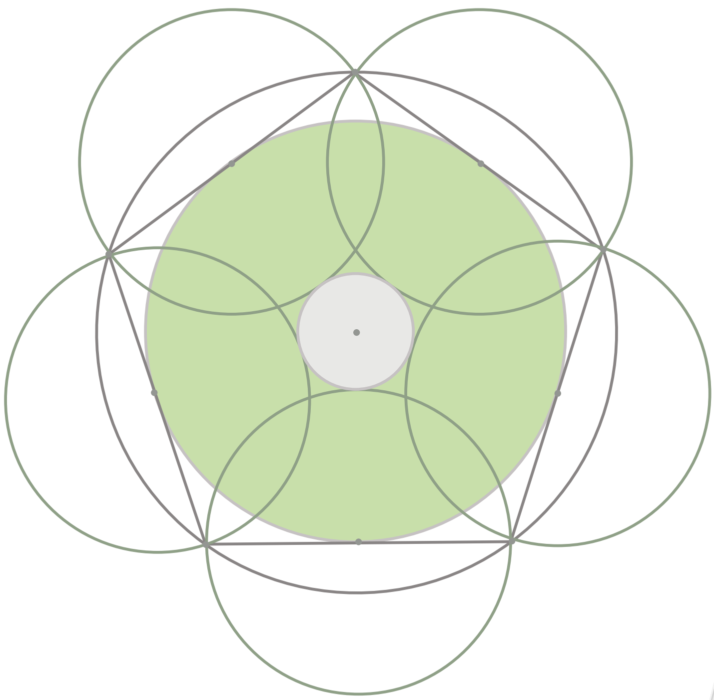
**LEARNING QUESTION** What are the relative sizes of the Earth and moon?

This activity is part of a Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning about the Solar Sytem, linked to the principle of the Cycle. The wider enquiry allows students to explore the attributes of the solar system and the effect it has on life on Earth.

This activity offers an accessible way to explore the relationship between the dimensions of the Earth and moon, and their 11:3 ratio. The size of the moon has an impact on some things we observe from Earth. For example, although the sun is much larger than the moon, it is also much further away; from the perspective of someone on Earth, the two objects appear to be about the same size. This is why we see total solar eclipses, where the moon appears to be the same size as the sun and is able to completely cover it.

## YOU WILL NEED

An HB pencil
A ruler
A good compass
Coloured pencils
A good-quality eraser
Copies of Resource 3A
*Optional: Copies of Resource 3B*



The picture below shows the Earth and moon in 2015 as seen from the DSCOVR Satellite.

## DID YOU KNOW?

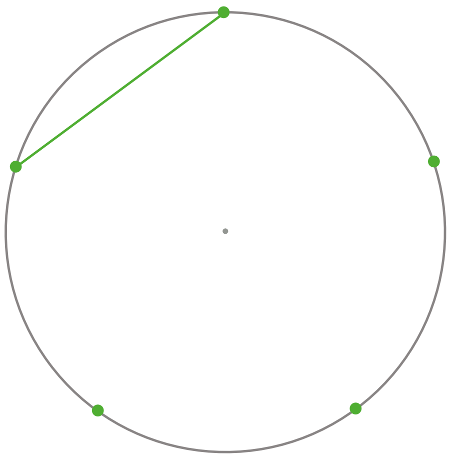
The distance between the Earth and the moon can be approximated with 13 sheets of A4 paper. Cut out a moon (a circle with a diameter of 3.5cm) and an Earth (a circle with a 12.8cm diameter). The distance between them would be 384cm at this scale. Place 13 sheets of A4 paper in portrait orientation between your moon and Earth to get a sense of scale!



Image credit: NASA

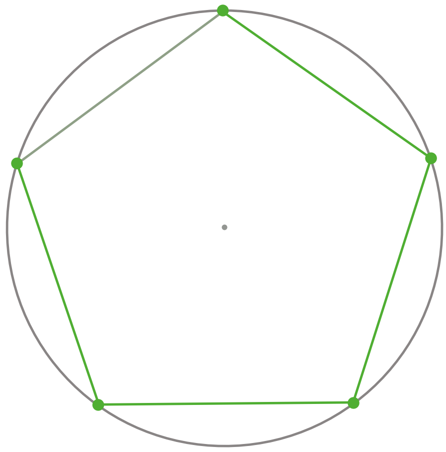
## STEP 1 Draw the first side of a pentagon

Use a ruler to connect two adjacent dots on the circumference of the circle on the template in Resource 3A. There are five dots in total; joining these first two forms the first side of a regular pentagon.



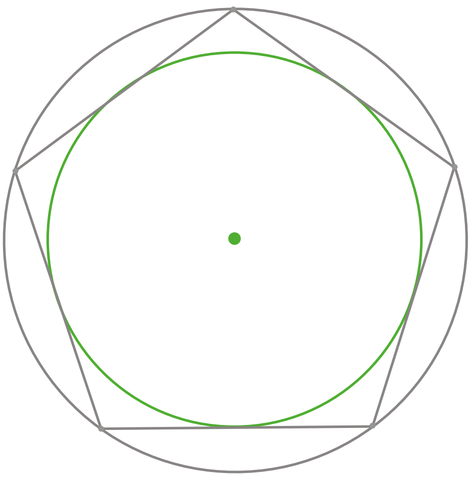
## STEP 2 Complete the pentagon

Using a ruler, continue joining adjacent dots around the circumference of the circle until you have drawn the five sides of the pentagon.



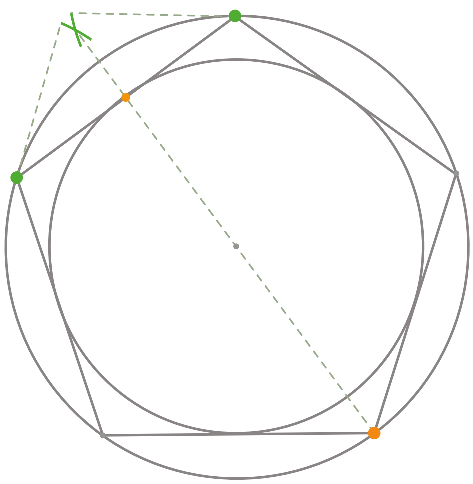
## STEP 3 Draw a circle within the pentagon

Place the point of the compass on the centre point of the pentagon and widen the arms until the pencil point touches every side of the pentagon. Draw a circle. This is your 'Earth' circle, representing the dimensions of the Earth.



## STEP 4 Bisect one of the sides

Place the compass point on one of the vertices of the pentagon. Draw an arc roughly over the mid-point of one side of the pentagon. Repeat, placing the compass point on the vertex at the other end of the same side. The two arcs should form a cross. Line up a ruler to pass through this cross and the opposite vertex of the pentagon. Mark where this cuts through the side of the pentagon.

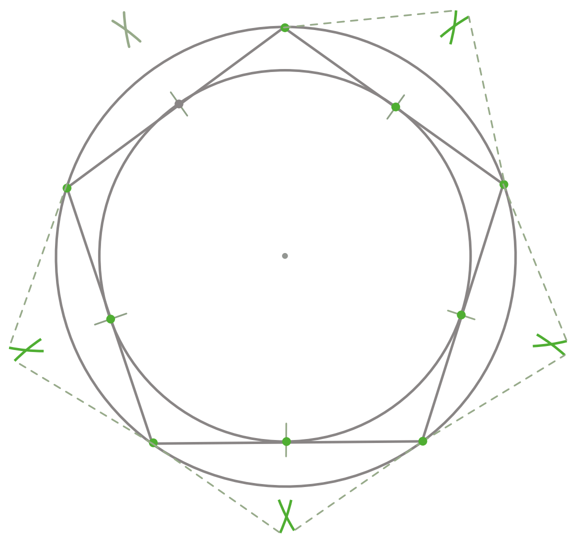


### TEACHER TIP

A good compass makes these activities much easier to follow. If compasses aren't available, string, strips of paper and a ruler can be used with the photocopiable resources provided.

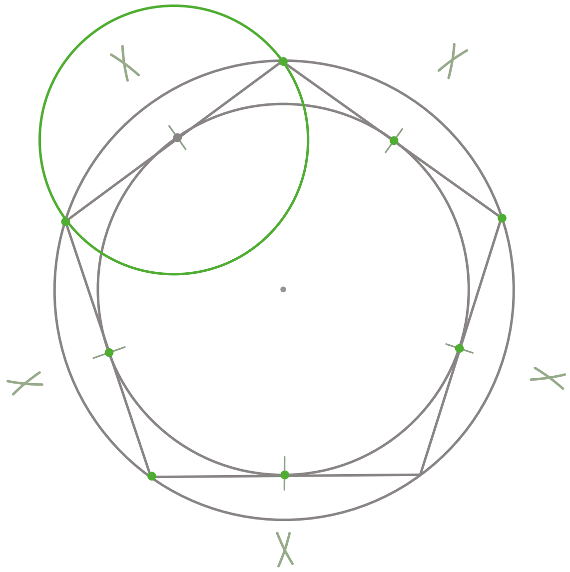
## STEP 5 Bisect the remaining sides

Repeat the process shown in Step 4 to bisect the remaining four sides of the pentagon. This will establish the mid-point of each side. Alternatively, students can measure the distance from one vertex to the midpoint they found in Step 4, then use this to find the mid-points of the remaining sides.



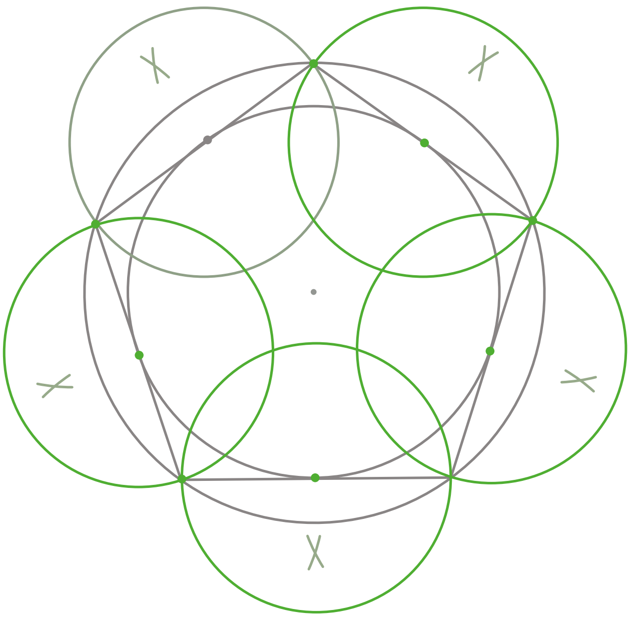
## STEP 6 Draw a circle with a diameter of one side length

Place the point of the compass on the mid-point mark of one side of the pentagon. Extend the arms of the compass so that the pencil point rests on one of the vertices at either end of that side. Draw a circle; its diameter should be equal to the side length of the pentagon.



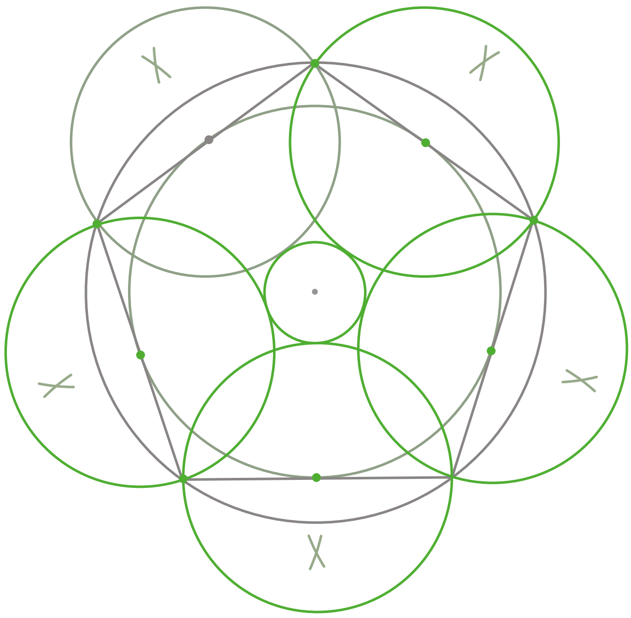
## STEP 7 Draw four more circles

Repeat Step 6 on every side of the pentagon. To ensure that each circle is accurately drawn, check that the distance between the point and pencil point of the compass (the radius) is equal to half the side length of the pentagon every time.



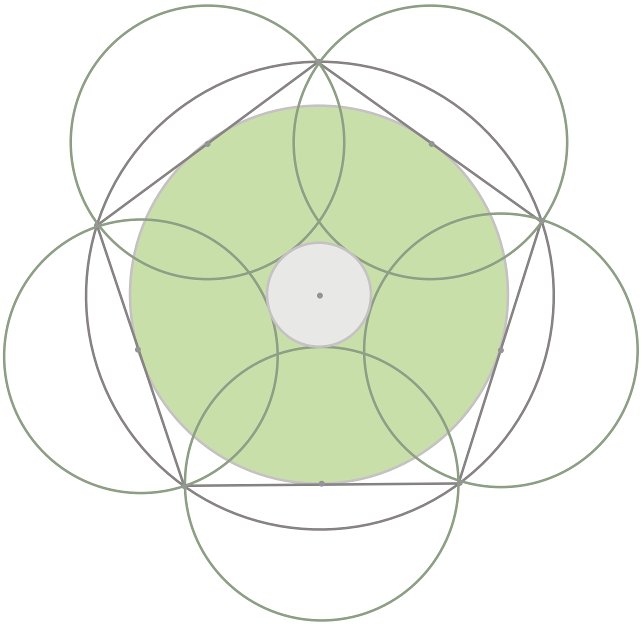
## STEP 8 Draw a circle representing the moon

The five overlapping circles leave a space at the centre. This is where you can draw the final circle; this circle represents the moon and shows its size relative to the Earth. To find the dimensions of this circle, place the point of the compass on the centre point of the diagram. Now adjust the arms so that the pencil point rests on the nearest point on the circumference of all five circles, as shown below.



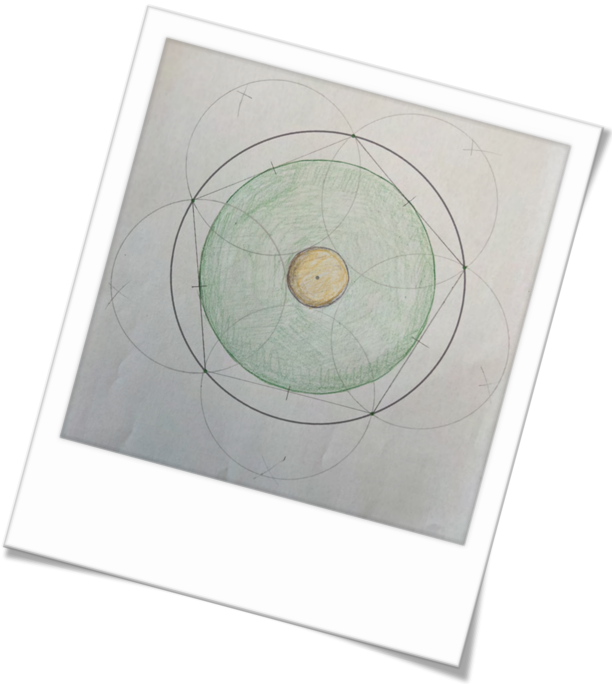
## STEP 9 Colour the diagram

The Earth at this scale is 11cm in diameter and the moon sitting at the centre is 3cm. Colour the Earth and moon to create some contrast between them. If you wish, you can use an eraser very carefully to rub out the construction lines around the circumference of the Earth circle, or leave them as evidence of the construction process.



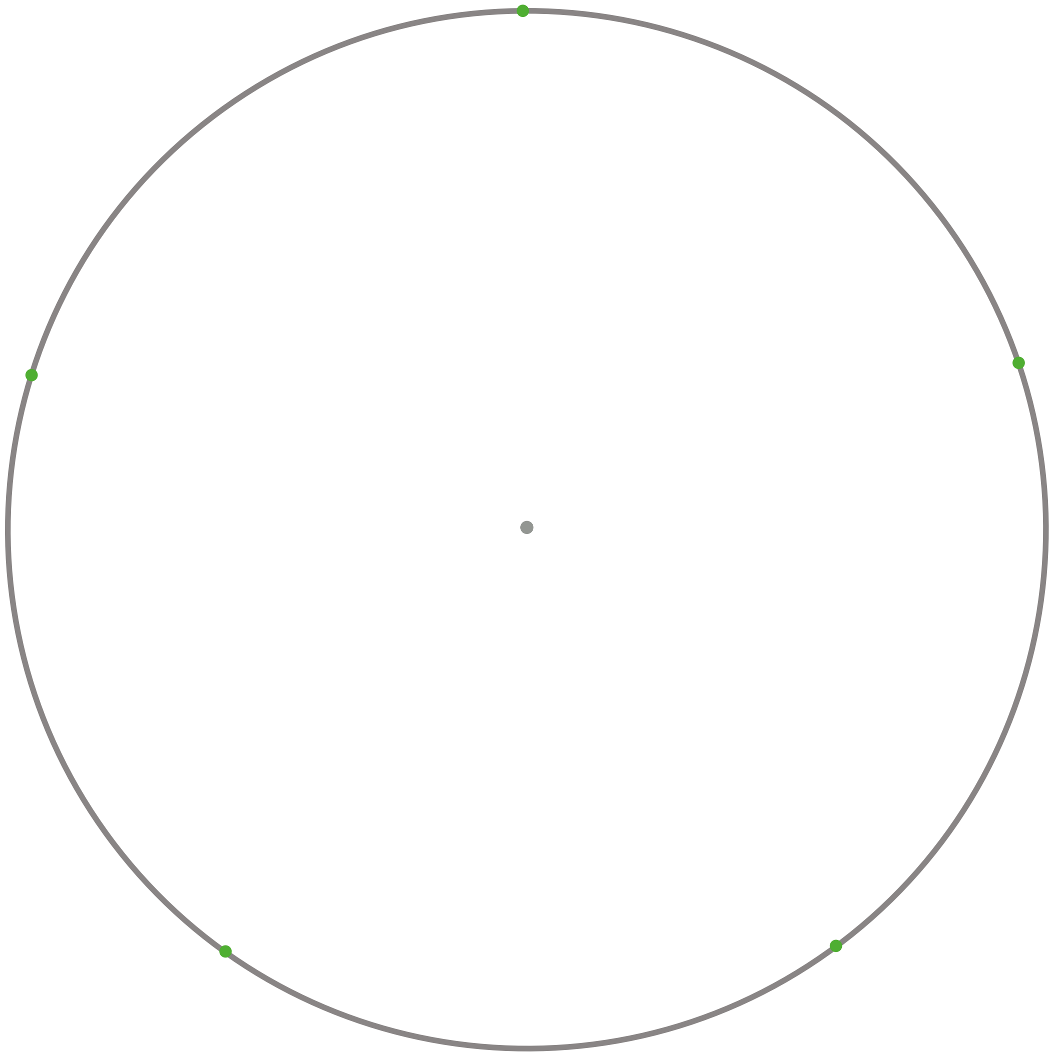
## DID YOU KNOW?

The Earth is much larger and heavier than the moon, so it has a stronger gravitational pull. That means that the Earth pulls the moon towards it. However, the moon never crashes into the Earth because it is constantly moving in a circle.



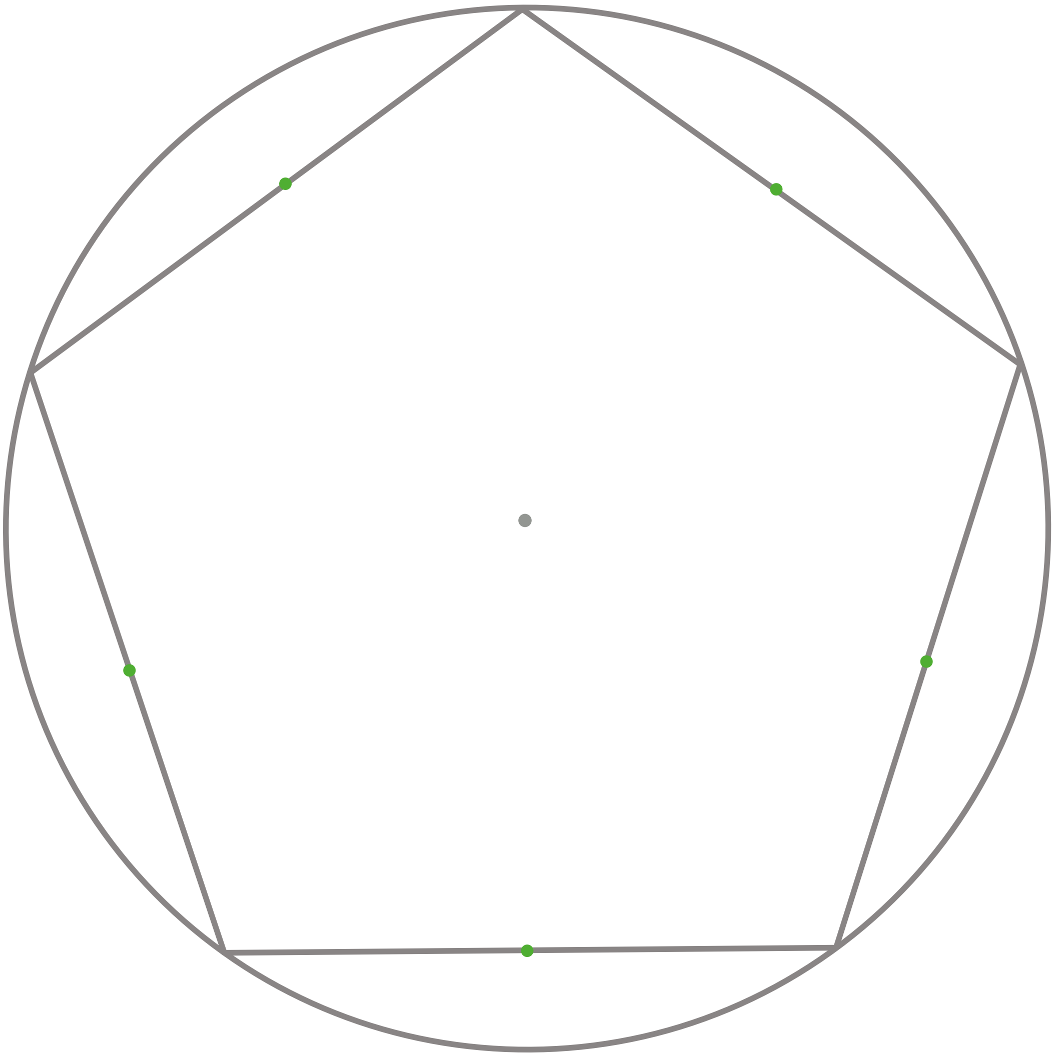
## PHOTOCOPIABLE RESOURCE 3A

Students will need a copy of this template to follow Steps 1-9.



## PHOTOCOPIABLE RESOURCE 3B

To simplify this activity for younger students, or for students who would benefit from additional support, photocopy this resource and follow Steps 6-9.



# GEOMETRY ACTIVITY 4

## **ENQUIRY OF LEARNING** What are the cycles of our solar system?

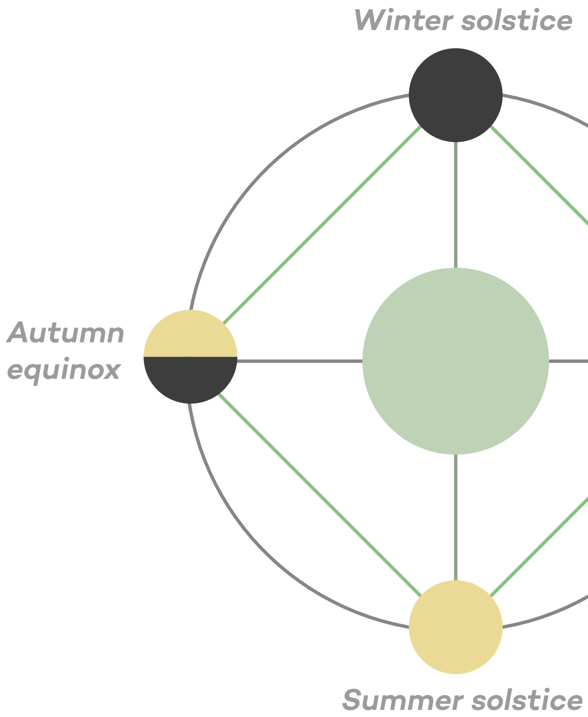
## **LEARNING QUESTION** Why do we have the cycle of the seasons on Earth?

This activity is part of a Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning about the solar system, linked to the principle of the Cycle. The wider enquiry allows students to explore the solar system and the effect it has on life on Earth.

The year is typically divided into four seasons: winter, spring, summer, and autumn. These seasons are determined by the position of the Earth in its orbit around the sun and the resulting changes in weather and temperature. Some people use the phrase the 'four corners of the year' to refer to the four equinoxes and solstices, which mark the beginning of each season. This activity will explore a geometric method of drawing and mapping the 'four corners of the year' as we experience them from our point of view on the Earth's northern hemisphere.

### YOU WILL NEED

An HB pencil
A ruler
A good compass
A sheet of A4 paper
A good-quality eraser
Coloured pencils
*Optional: Copies of Resource 4A and/or Resource 4B*

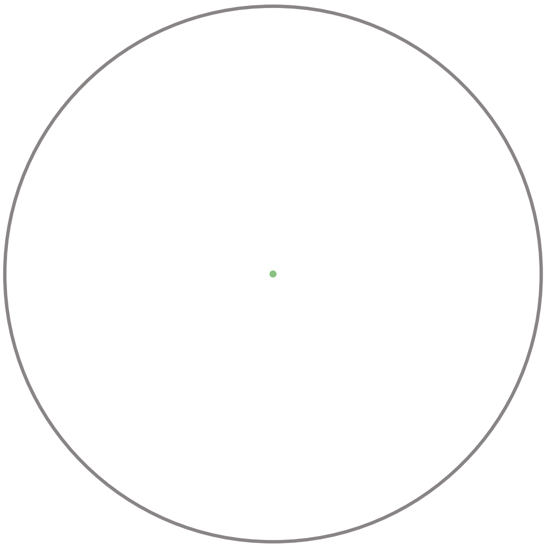



### DID YOU KNOW?

The solstices are important because they mark the longest and shortest days of the year. This helps people to know when to plant their crops and when to expect the seasons to change. During the summer solstice, the sun is at its highest point, and it shines directly over the centre of Stonehenge (a neolithic burial site of stone circles on Salisbury Plain in Wiltshire). This only happens once a year and it is believed that the ancient people who built Stonehenge used it to mark this special occasion. Stonehenge helps us to understand how people kept track of these important events in the past.

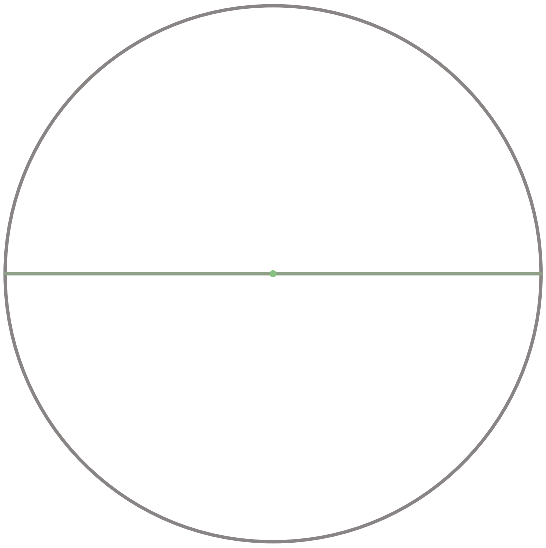
## STEP 1 Draw a circle

Mark a central point on the page. Set the arms of the compass so that the compass point and the pencil point are 7cm apart. Place the compass point on the central point you've marked and draw a circle.



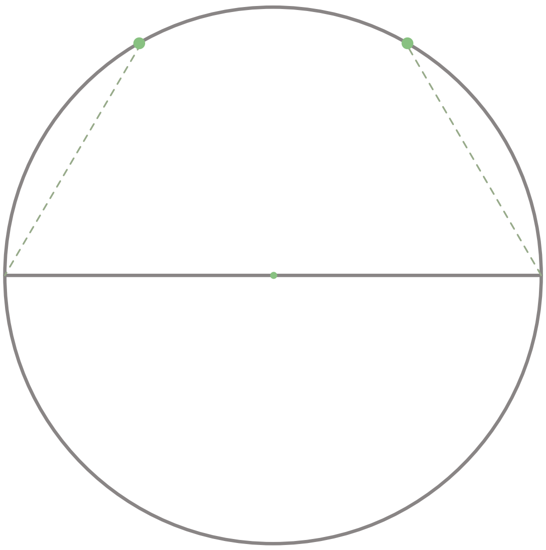
## STEP 2 Divide the circle horizontally

Use a ruler to draw a horizontal line that joins two opposite points on the circumference of the circle, passing through the centre point. This line marks the circle's diameter. The rest of the drawing will be built up relative to this line.



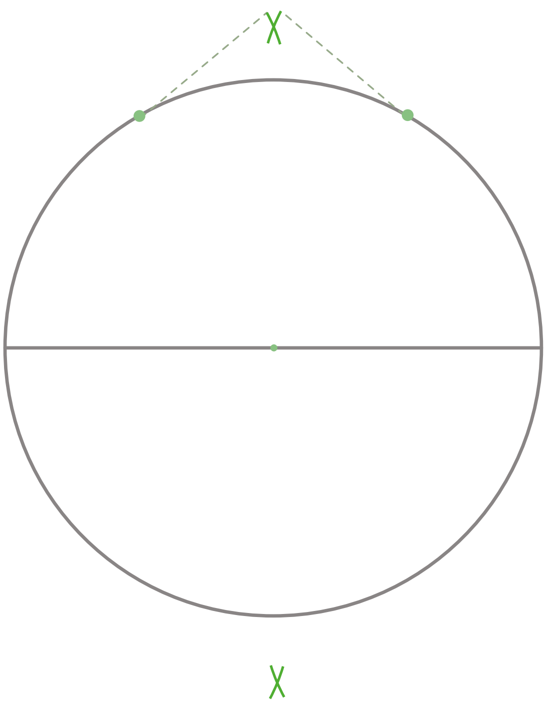
## STEP 3 Find the vertical bisector (1)

You now need to find the position of the vertical line that bisects the horizontal line at a right angle. Using a standard compass, this is a two-step process on such a large circle. Place the compass point at one of the points where the horizontal line meets the circumference of the circle. Use the compass to mark a point on the circumference of the circle. Without changing the distance between the arms of the compass, repeat this from the point at which the other end of the horizontal line meets the circumference of the circle.



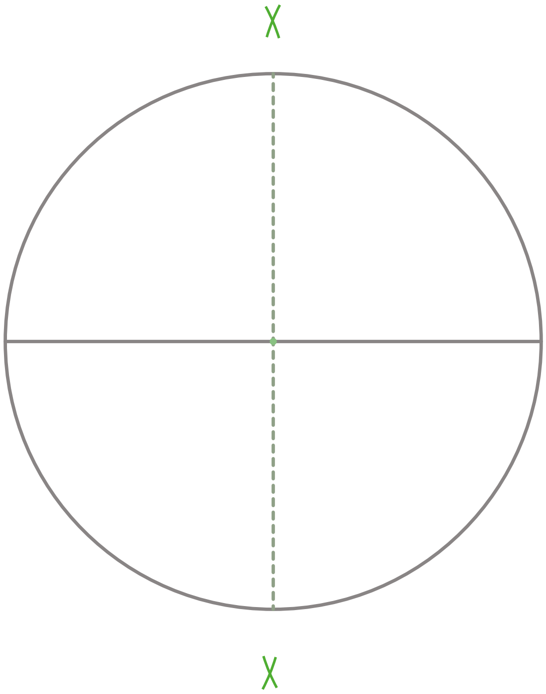
## STEP 4 Find the vertical bisector (2)

Set the distance between the compass point and the pencil point to 4cm. Placing the compass point at each of the two points marked in Step 3 in turn, draw a small arc over the centre of the circle. The two arcs should cross. Repeat the process outlined in Steps 3 and 4 in the lower half of the circle.



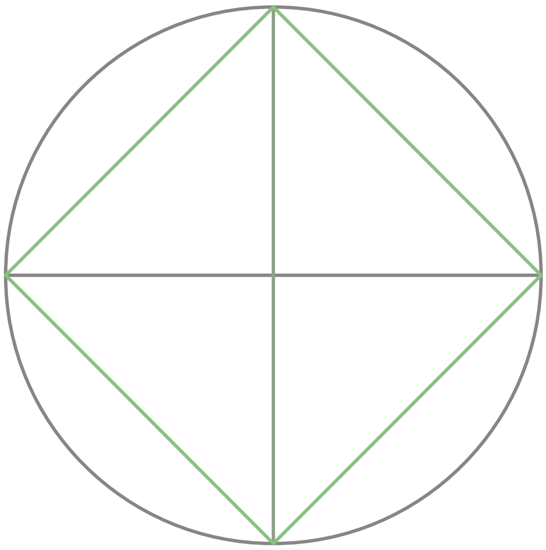
## STEP 5 Draw the vertical bisector

Using a ruler, draw a line that passes through the two small crosses made where the arcs meet and the centre point of the circle. This is the vertical bisector.



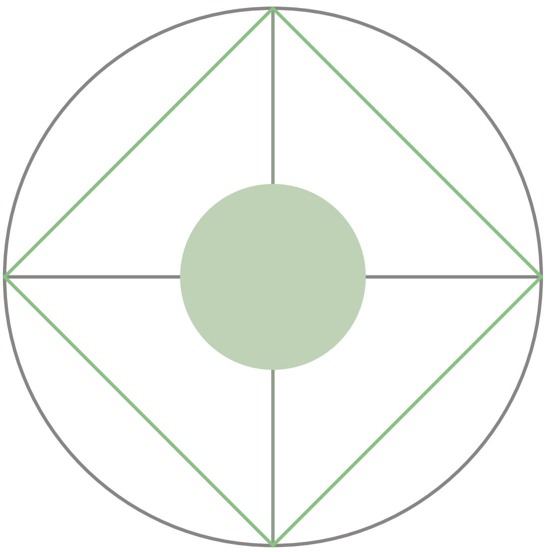
## STEP 6 Connect the points to draw a square

Use a ruler to connect the points at which the ends of the two lines you have drawn meet the circumference of the circle. This will create a square resting on one point, known as a dynamic square.



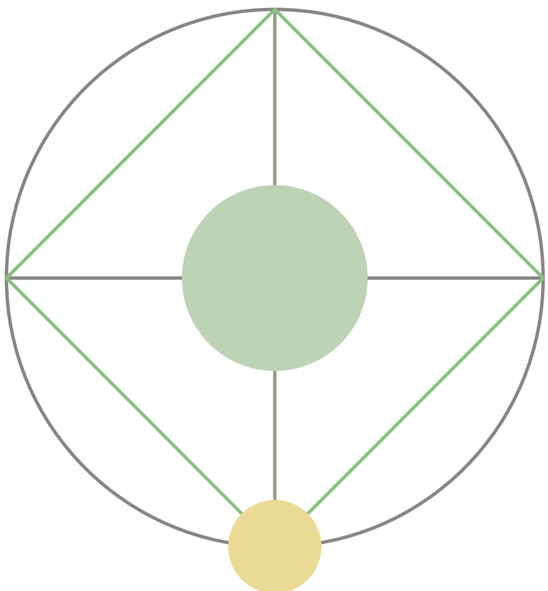
## STEP 7 Draw the Earth at the centre

Set the arms of your compass so that the distance between the compass point and the pencil point is approximately 3cm. With the compass point on the centre point of the circle, draw a circle at the centre of the diagram to represent the Earth.



## STEP 8 Draw the sun at the summer solstice

Reduce the distance between the compass point and the pencil point to 2cm. Placing the compass point on the bottom vertex of the square, draw a circle to represent the sun at the summer solstice (the longest day of the year). Colour this circle with a light colour to represent this.

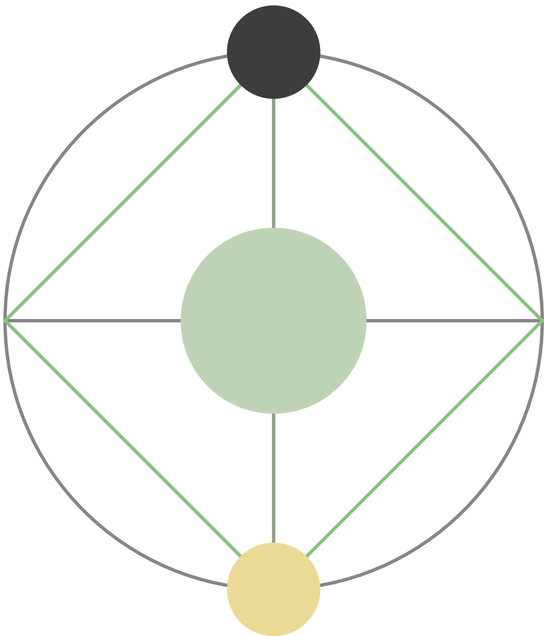


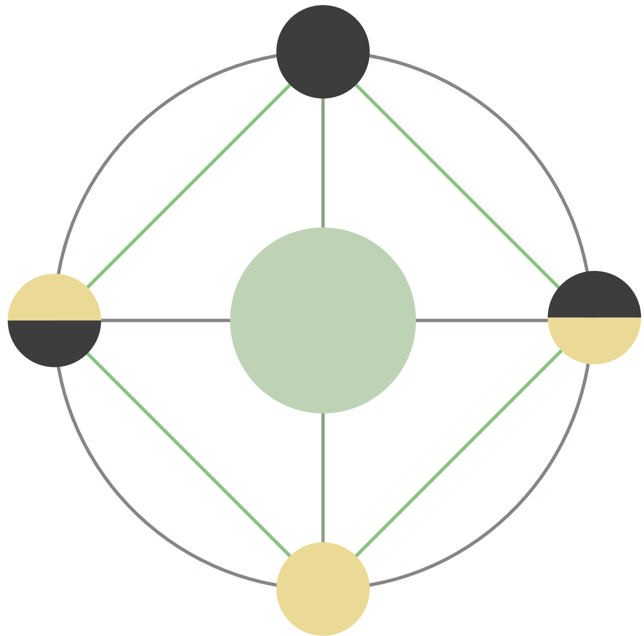
### STEP 9 Draw the sun at the winter solstice

Placing the compass point on the top vertex of the square, draw a circle at the top of the diagram (keep the distance between the compass point and the pencil point set to 2cm). This shows the sun at the winter solstice (the longest night). Colour this circle with a dark colour to represent this.

### STEP 10 Add circles to represent the equinoxes

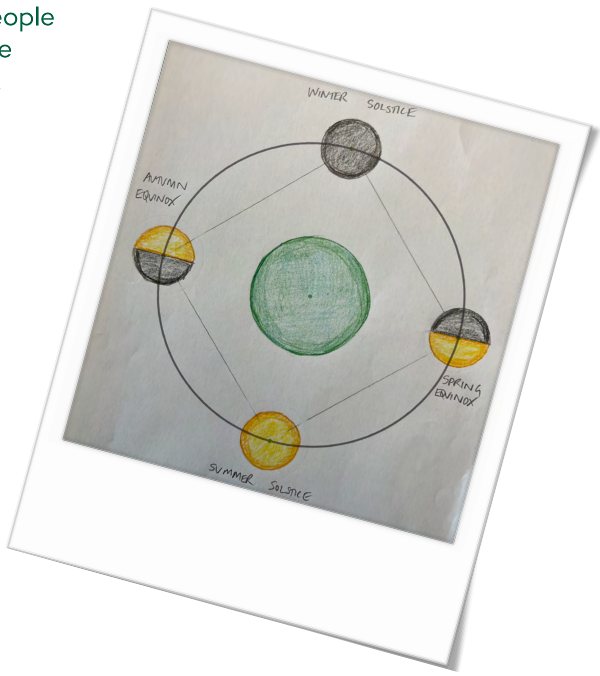
Placing the compass point on the left and right vertices of the square in turn, draw two circles to represent the autumn and spring equinoxes (when day and night are equal). Shade these to reflect the equal length of day and night, as shown below. Label the 'four corners of the year' to finish the diagram.





### DID YOU KNOW?

A solstice is a special time of year when the sun is at its farthest point from the equator, causing the longest or shortest day of the year, depending on the hemisphere. This occurs twice a year, around June 20 and December 21. The term 'solstice' comes from the Latin words 'sol', meaning 'sun', and 'sistere', meaning 'to stand still'. During the solstice, the sun appears to stop moving in the sky and either reaches its highest or lowest point, depending on the hemisphere. In the northern hemisphere, the June solstice is the summer solstice and the December solstice is the winter solstice. In the southern hemisphere, the opposite is true. Some people think that solstices are interesting because they mark the beginning of summer and winter, and they remind us that the Earth is always moving and changing through its seasonal cycle.

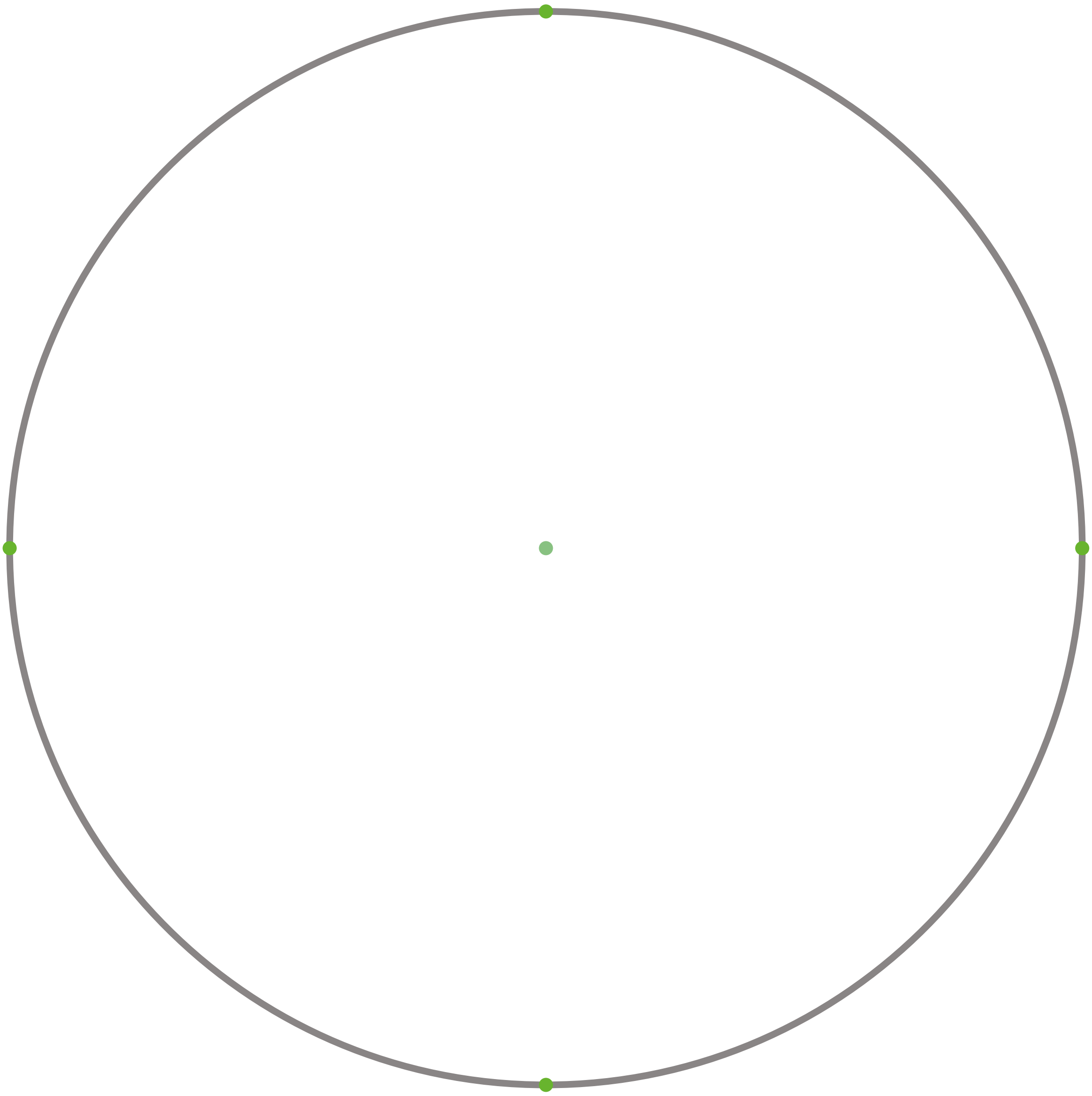



### HOW CAN THIS ACTIVITY BE ADAPTED?

Use the printable resources on p. 28 and p. 29 to adapt this activity for younger students or students requiring additional support. They can also be used if compasses are not available.

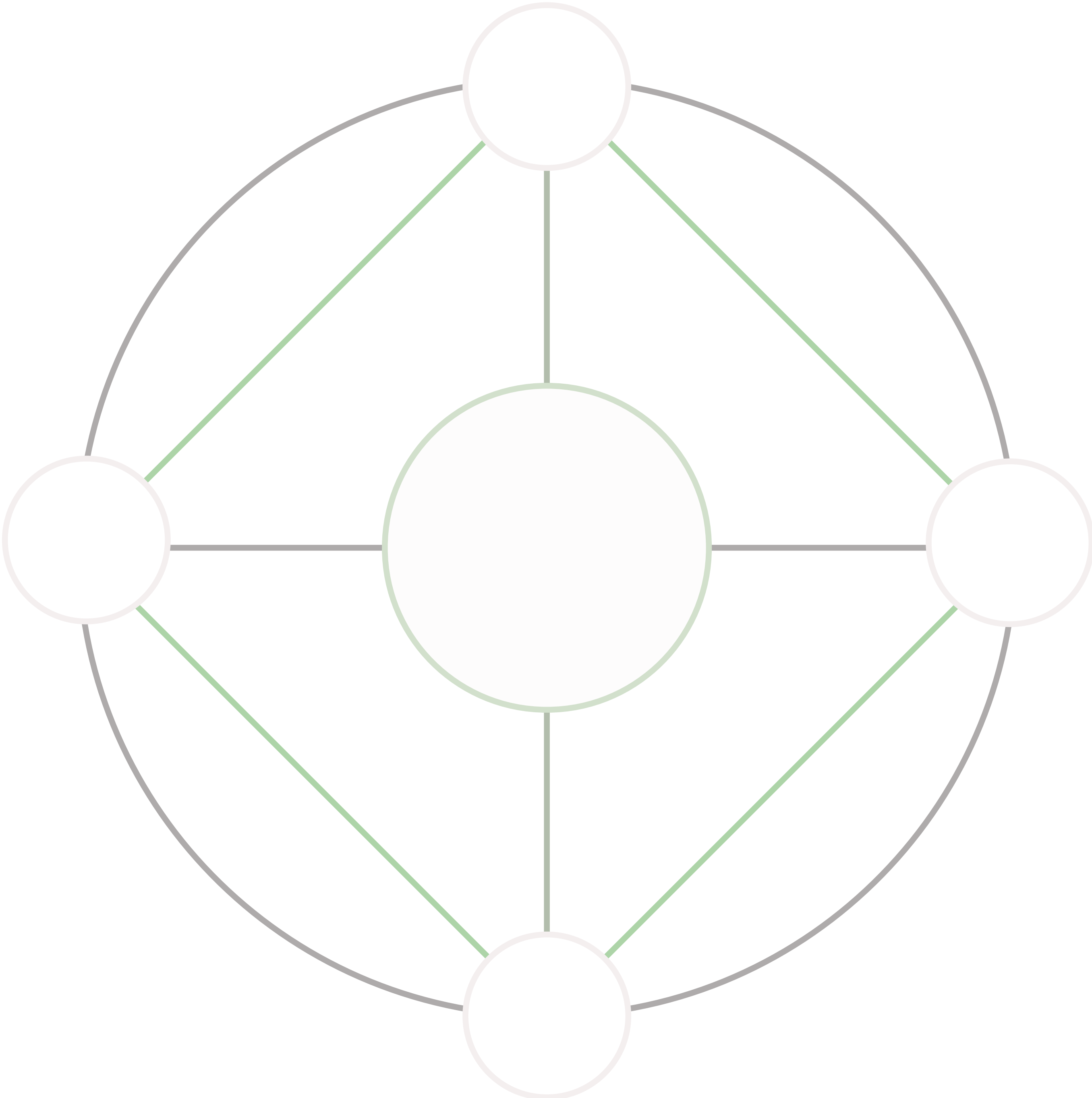
## PHOTOCOPIABLE RESOURCE 4A

This template can be photocopied and given to students to follow Steps 6-10.



## PHOTOCOPIABLE RESOURCE 4B

To simplify this activity for younger students, or for students who would benefit from additional support, photocopy this resource and shade and label the diagram as shown in Step 10.



# GEOMETRY ACTIVITY 5

## **ENQUIRY OF LEARNING** What are the cycles of our solar system?

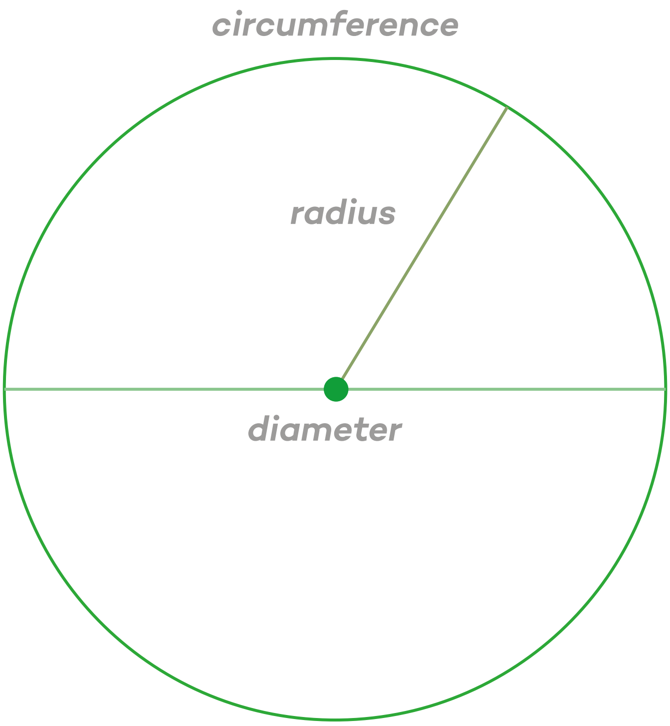
## **LEARNING QUESTION** How big are the planets in our solar system?

This activity is part of a Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning about the solar system, linked to the principle of the Cycle. The wider enquiry allows students to explore the attributes of the solar system and the effect it has on life on Earth.

The planets in our solar system are all different sizes. Some are very large, like Jupiter and Saturn, while others are small, like Mercury. The largest planet is Jupiter, which is so big that all of the other planets in the solar system could fit inside it. Despite their differences in size, all of the planets in our solar system are equally fascinating. This activity explores the different sizes of these planets so students can get a better sense of the relationships between them. It links well to maths learning about diameter and radius.

### YOU WILL NEED

An HB pencil
A ruler
A good compass
A printed template
Coloured pencils
A good-quality eraser
*Optional: copies of Resource 5A*

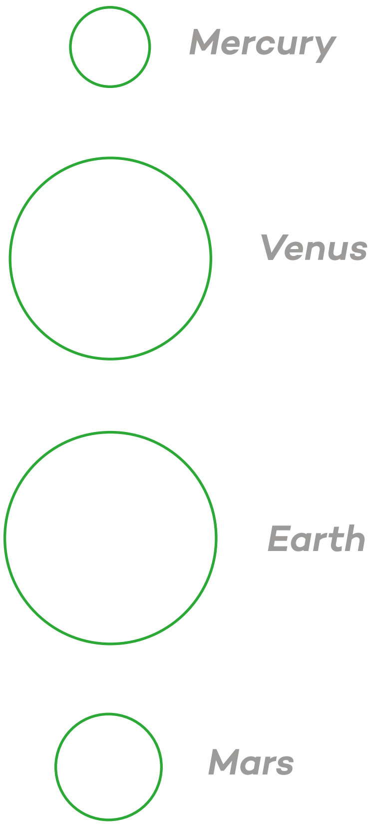



### DID YOU KNOW?

The smallest planet in our solar system is Mercury, which is only slightly larger than Earth's moon. The largest planet is Jupiter, which is more than 11 times wider than Earth and more than 300 times as massive.

## STEP 1 Draw Mercury, Venus, Earth and Mars

These four planets are the closet to the sun and are also the most similar in size. Relative sizes and their measurements are given below.

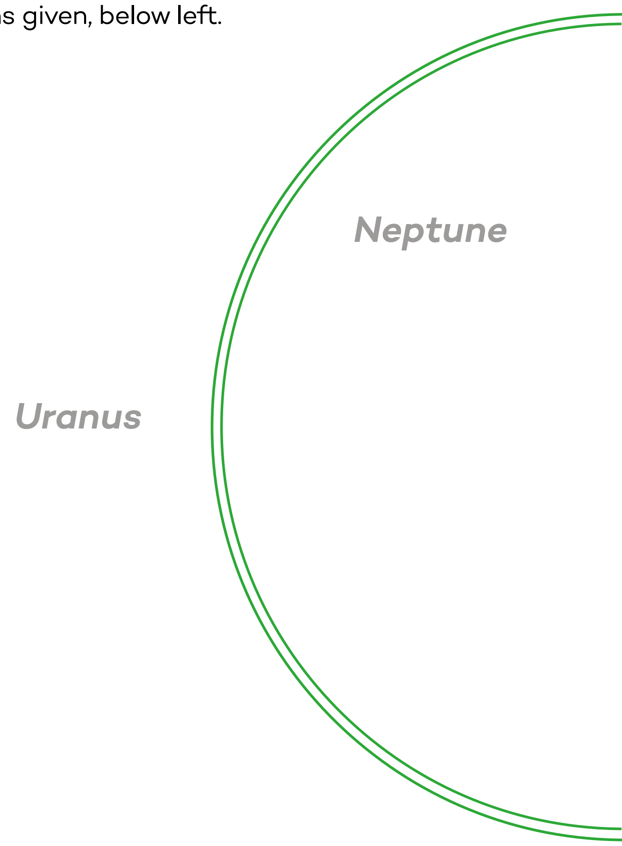



### TEACHER TIP

These circles are sized to fit an A4 page and show, as much as possible at this scale, the relative sizes of the planets. When working with students, you may wish to scale up these measurements two or four times to make drawing the planets easier. At these larger scales, Jupiter, Saturn, Uranus and Neptune can be drawn more readily with a piece of string, drawing pin and pencil.

## STEP 2 Draw Uranus and Neptune

These two planets are the most distant from the sun in our solar system and are mid-sized compared with the smaller and larger planets. A compass will work to draw the circumference of Uranus and Neptune relative to the other planets using the dimensions given, below left.




## DIAMETERS OF THE PLANETS AS THEY ARE DRAWN ON THIS PAGE

| | |
|---|---|
| Mercury: | 1cm |
| Venus: | 2.6cm |
| Earth: | 2.8cm |
| Mars: | 1.4cm |
| Jupiter: | 30cm |
| Saturn: | 25cm |
| Uranus: | 11cm |
| Neptune: | 10.7cm |

Saturn

## STEP 3 Draw Jupiter and Saturn

The next two planets are the giants of our solar system. All the other planets would fit within Jupiter alone! Depending on the scale you are working with, you may want to use string rather than a compass to draw these circles. You would have to back your piece of paper onto some card or a display board. Using a length of string, fix one end in place with a thumb tack and attach a pencil to the other end. Keeping the string pulled tight, draw a circle.

## HOW CAN THIS ACTIVITY BE ADAPTED?

Children requiring additional support can use the planet templates on the photocopiable resource on p. 34 to explore the comparative size of the planets in our solar system.

Jupiter

## DID YOU KNOW?

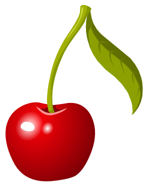
Another way to compare the sizes of the planets is to look at how long it takes them to orbit the sun. For example, Jupiter takes about 12 Earth years to complete one orbit, while Mercury takes just 88 days.

## ACTUAL RADII OF THE PLANETS IN OUR SOLAR SYSTEM

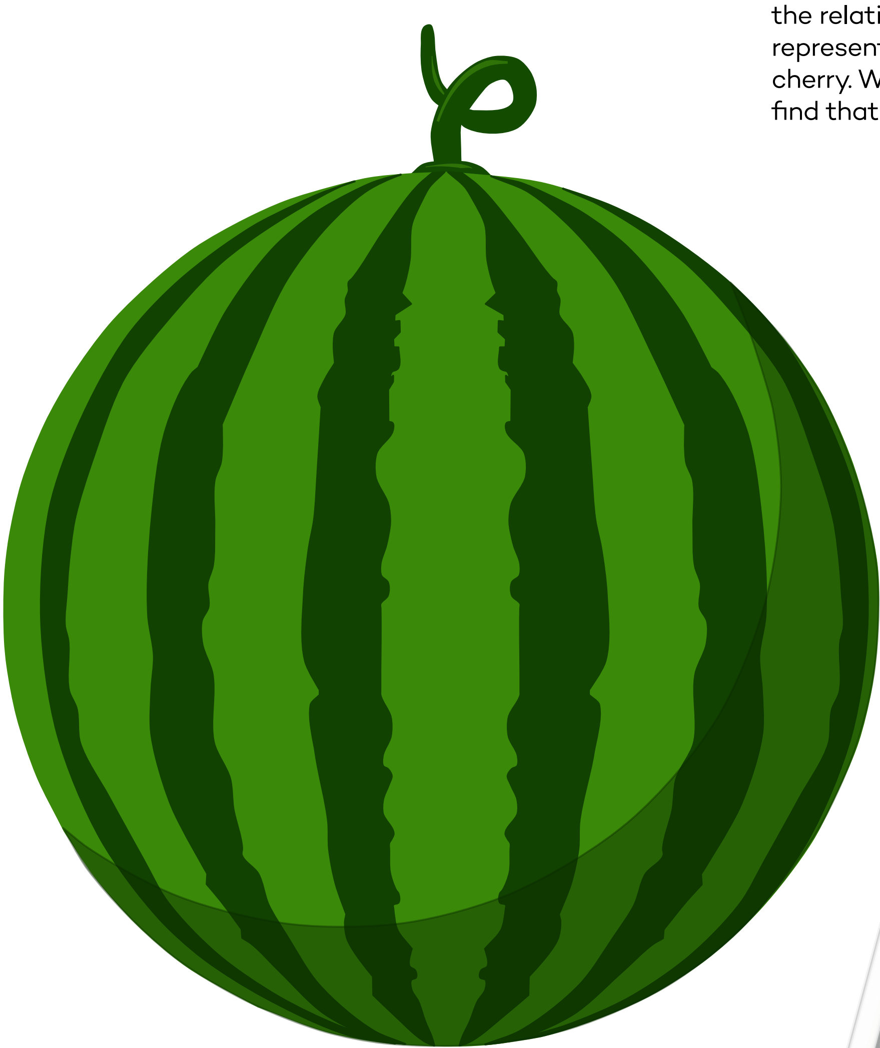
| | |
|---|---|
| Mercury: | 2, 440km (much smaller than Earth) |
| Venus: | 6, 052km (slightly smaller than Earth) |
| Earth: | 6, 371km |
| Mars: | 3, 390km (about half the size of Earth) |
| Jupiter: | 69, 911km (roughly 11x Earth's size) |
| Saturn: | 58, 232km (9x larger than Earth) |
| Uranus: | 25, 362km (4x Earth's size) |
| Neptune: | 24, 622 km (4x Earth's size) |

### TEACHER TIP

Explore the different scales of the planets in 3D using fruit! Below is a scale illustration of the relationship between Jupiter and Earth represented by a large watermelon and a cherry. What other spherical fruits can you find that could represent the other planets?



*Earth*

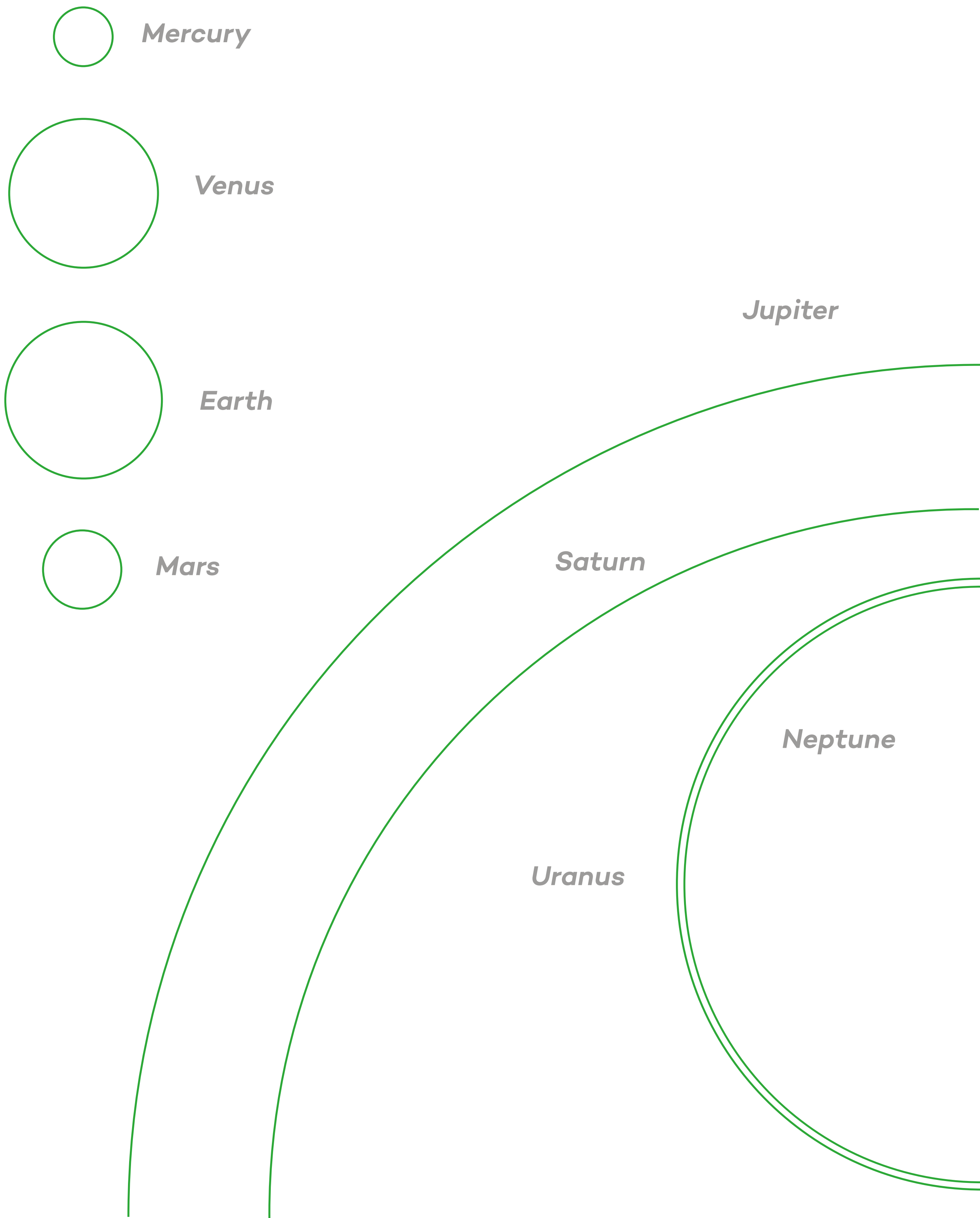


*Jupiter*


The Harmony Project

## PHOTOCOPIABLE RESOURCE 11

Use this resource to simplify this activity for younger students, or for students who would benefit from additional support. Where only part of the largest planets is shown, these sections can be traced, or several students could each cut them out of their template and stick them together to complete the planet.



# GEOMETRY ACTIVITY 6

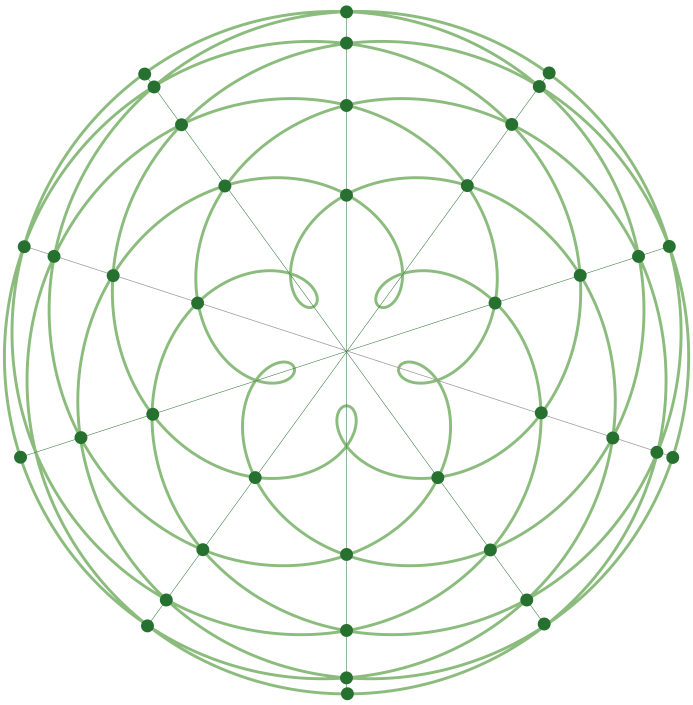
## **ENQUIRY OF LEARNING** What are the cycles of our solar system?

## **LEARNING QUESTION** How can I recreate the orbit of Venus?

This activity is part of a Year 4 (Year 5 in Northern Ireland; P5 in Scotland) enquiry of learning about our solar system, linked to the principle of the Cycle. The wider enquiry allows students to explore the attributes of the solar system and the effect it has on life on Earth.

This activity explores cycles and planets, and touches on the idea of *heliocentric* and *geocentric* models of the solar system. The geocentric model is a historic system of thought that believed the Earth was the centre of our solar system and that all the other planets, stars and objects in the sky revolved around it. The heliocentric model of the solar system is the current understanding based on the observation that the sun, not the Earth, is at the centre of the solar system. However, a geocentric view can show us interesting patterns in the cycles of the solar system. For example, over a period of eight years, Venus creates a five-fold flower pattern, which also looks similar to the cross-section of an apple (see below). In this activity, students trace the orbit of Venus around the sun as viewed from the Earth over eight years and construct a simple pentagonal flower using a compass.

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



The diagram, left, shows the orbit of Venus as viewed from Earth. The image below shows a cross section of an apple. What do they have in common?

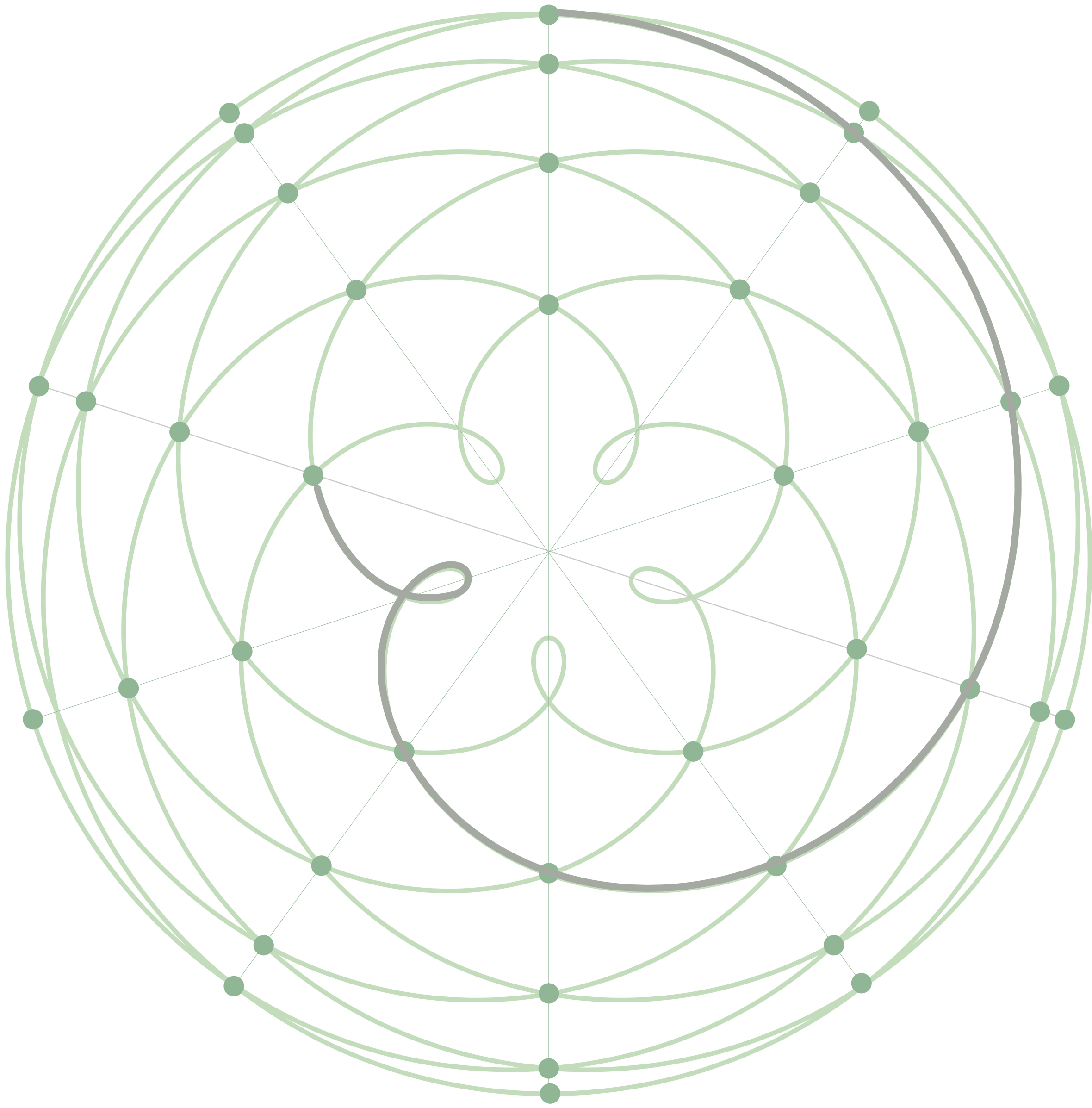
### TEACHER TIP

A great animation of the pattern created by the orbit of Venus around the sun, as viewed from Earth, can be found on the EarthSky website at: earthsky.org/astronomy-essentials/five-petals-of-venus/.

## STARTER ACTIVITY Dance of Venus

The diagram below represents the geocentric view, from Earth, of the orbit of Venus around the sun during eight Earth years. This orbit, also known as the 'dance of Venus', takes 13 Venus years to complete. Since eight Earth years is equal to 13 Venus years, the difference of five between these numbers creates the rose pattern that we observe. The rose, pentagon and apple have traditionally symbolised Venus in Greek and Roman mythology due to the pentagonal shapes found in them.

Using a pen or pencil, start at one of the marked points on a copy of Resource 6A and trace the orbit slowly, getting a sense of the curves and loops that occur within it.



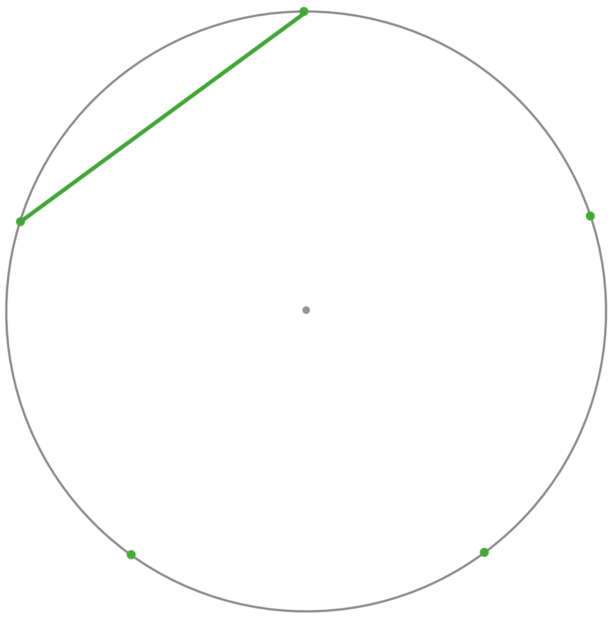
### DID YOU KNOW?

Venus is the second planet from the sun and is the brightest object in the sky after the sun and the moon. Because Venus is closer to the sun than the Earth, it orbits the sun more quickly and, as a result, it appears to move more rapidly across the sky. This can create the illusion of a 'dance' as Venus appears to move back and forth in front of the fixed background of stars. The 'dance of Venus' is a term that is sometimes used to describe the way in which Venus appears to move in relation to the Earth and the sun.

## MAIN ACTIVITY Exploring five-pointed forms

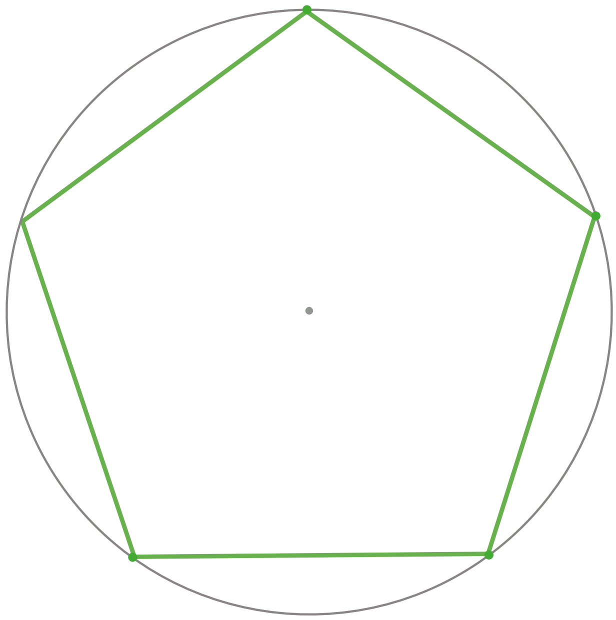
### STEP 1 Draw one side of a pentagon

On a copy of Resource 6B, use a ruler to join two adjacent dots on the circumference of the 15cm-diameter circle to form one side of a pentagon.



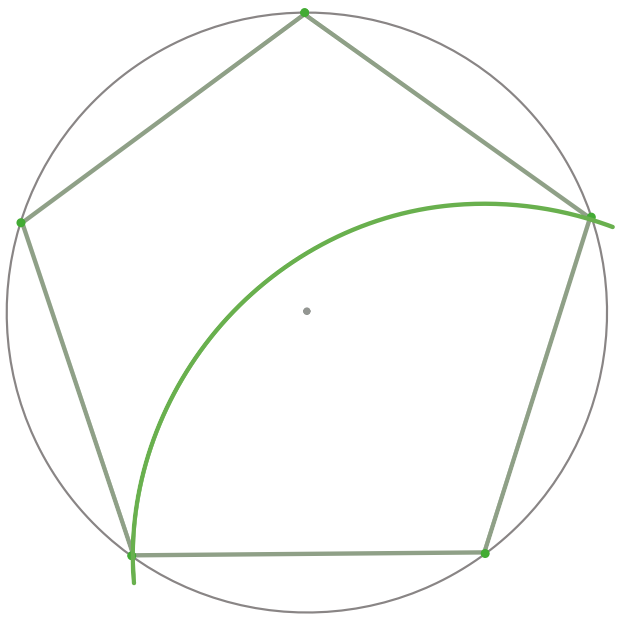
### STEP 2 Draw the remaining sides

Using a ruler, continue joining adjacent dots to complete the outline of the pentagon. Measure the side lengths to check that this is a regular pentagon.



### STEP 3 Draw an arc

Place the point of the compass on one of the vertices at the bottom of the pentagon. Adjust the arms of the compass so that the distance between the point and the pencil point is equal to the length of one side of the pentagon. Draw an arc.



### TEACHER TIP

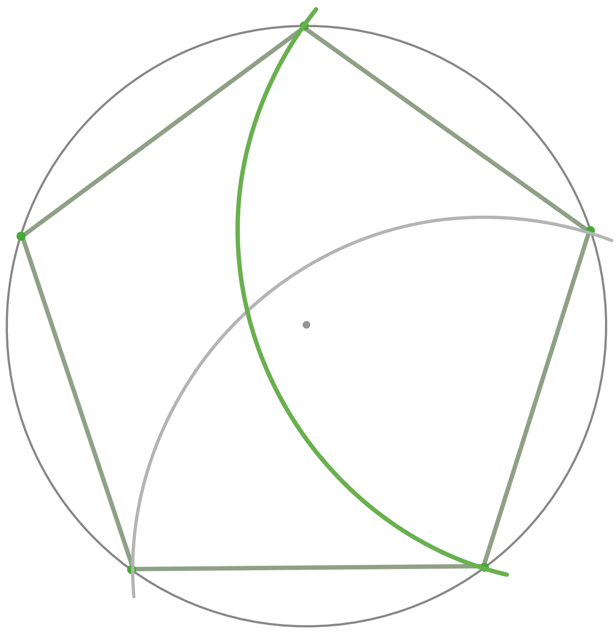
A good compass makes these activities much easier to follow. If compasses aren't available, string, strips of paper and a ruler can be used with the photocopiable resources provided.

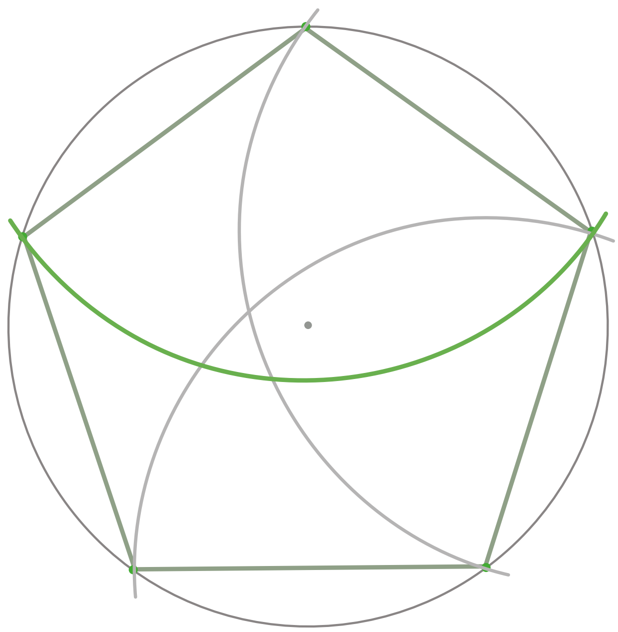
## STEP 4 Draw a second arc

Without adjusting the distance between the arms of the compass, place the point of the compass on a second vertex and repeat Step 3 to draw a second arc. It may be useful to work in one direction around the points on the edge of the circle.

## STEP 5 Draw a third arc

Double-check the distance between the arms of the compass against one side of the pentagon. Placing the compass point on a third vertex, draw a third arc.



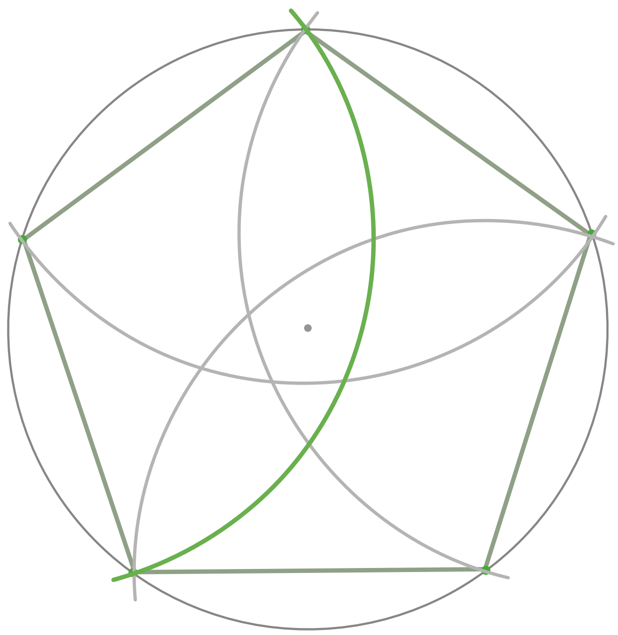


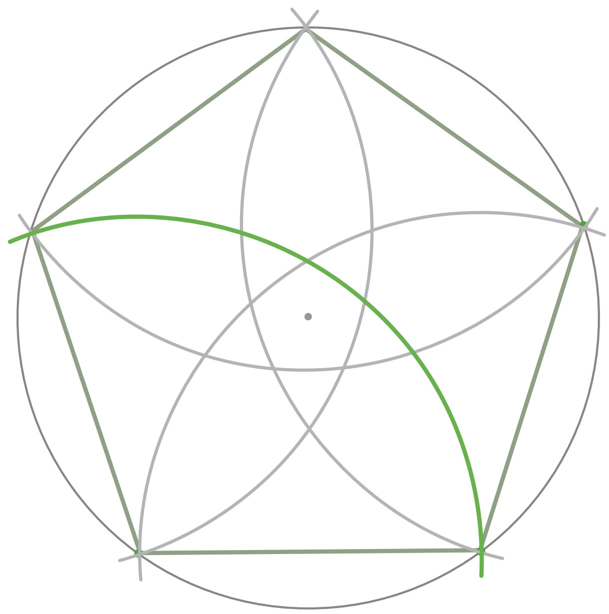
## STEP 6 Draw a fourth arc

Placing the compass point on a fourth vertex, draw a fourth arc. The flower that is emerging has five-fold symmetry, similar to the shape at the centre of the 'dance of Venus' pattern.

## STEP 7 Draw the final arc to complete the five-fold pattern

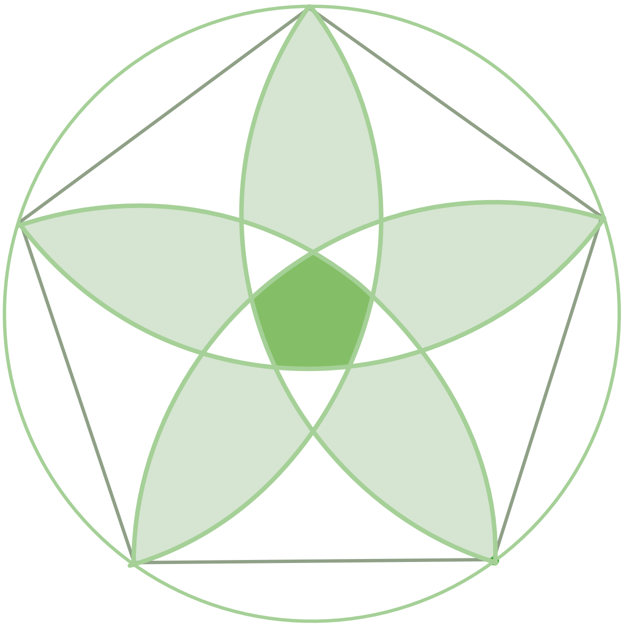
Placing the compass point on the final vertex, draw a fifth arc. You should be able to see a flower with two layers of petals. What difference do you start to notice between this five-fold flower and the 'dance of Venus'?

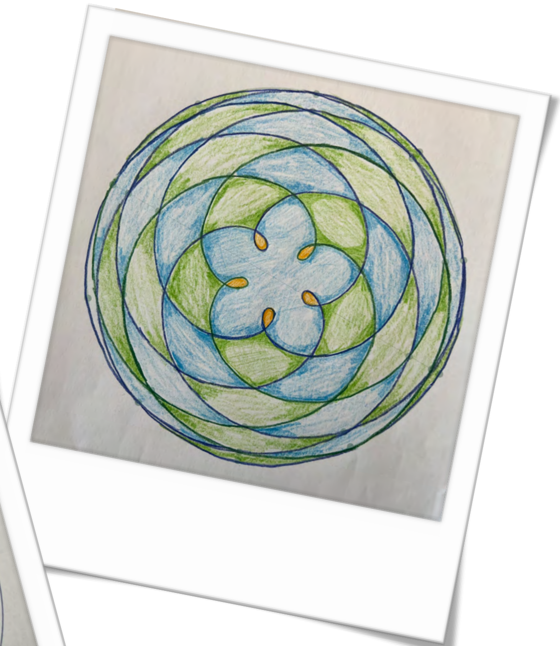


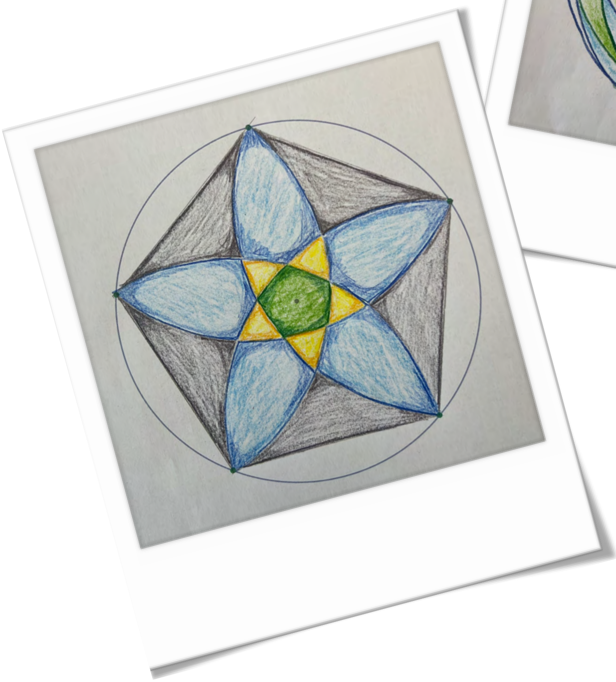


## STEP 8 Add colour

Use colouring pencils to colour the pentagonal forms you have created. Leave some white space for contrast or use complementary colours to make the design really stand out.





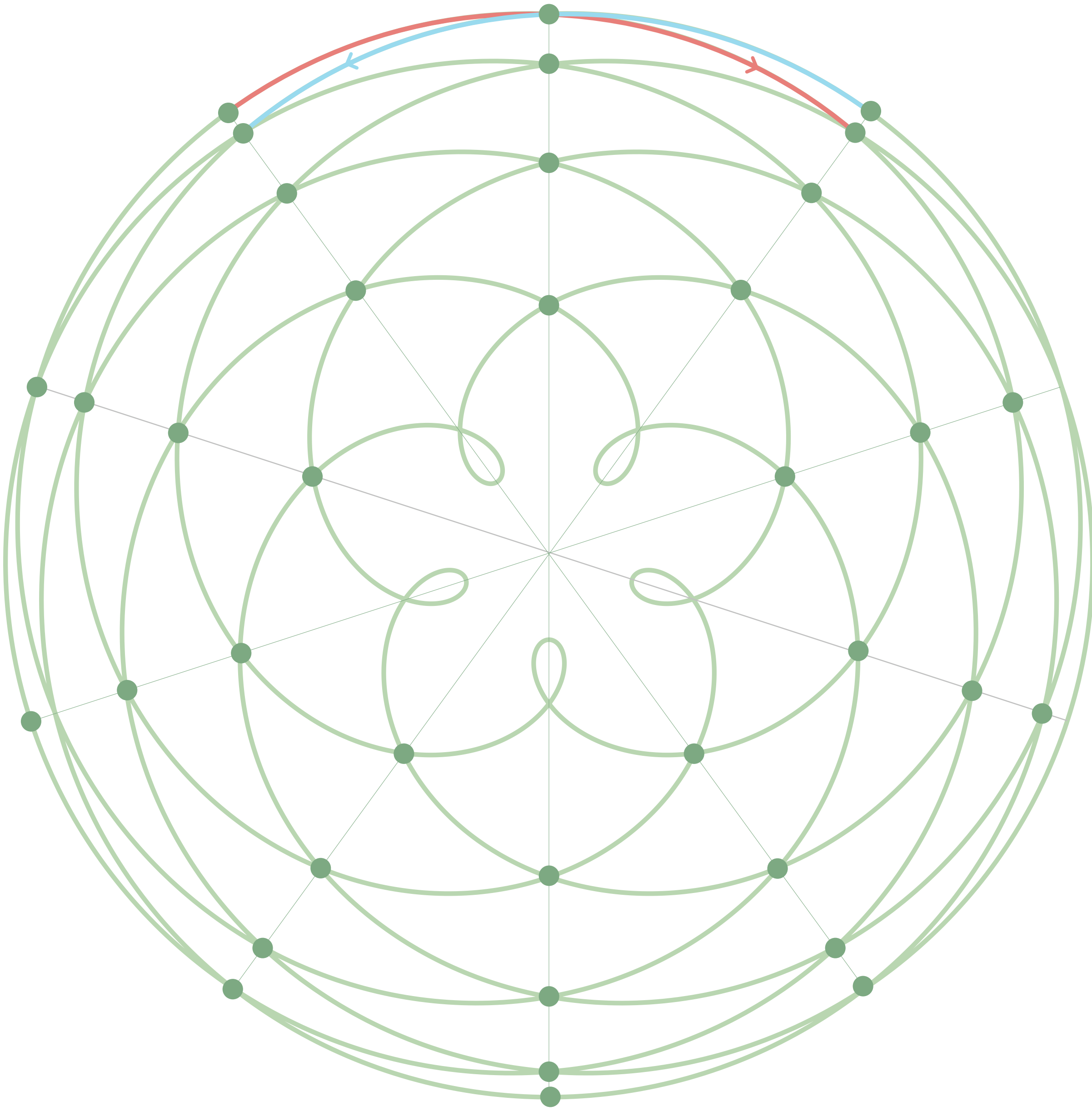


## PHOTOCOPIABLE RESOURCE 6A

Using a pen or pencil, start at one of the marked points and slowly and carefully trace the orbit of Venus, getting a sense of the curves and loops within it.

### TOP TIP

If you are tracing a line along the edge of the circle, it will curve inwards, as shown below. A line approaching the edge of the circle will then curve along the outer edge of the circle.



## PHOTOCOPIABLE RESOURCE 6B

Use this template to complete Steps 1-8.