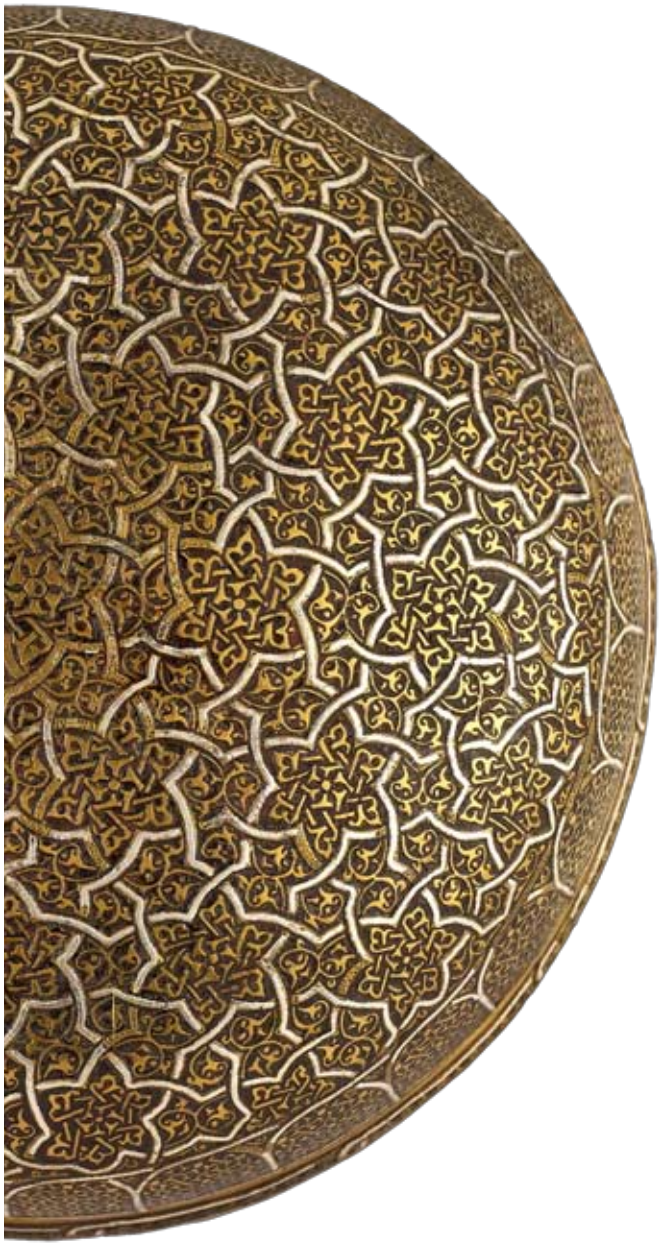
THE COURTAULD Gallery

CREATIVE CONNECTIONS



ART AND MATHS

PROJECT WORKBOOK

THIS BOOK BELONGS TO:

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CLASS / YEAR GROUP:

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INTRODUCTION

This workbook has been created in order to identify the clear and fascinating connections between The Courtauld's Islamic metalwork and Italian Maiolica ceramic collections and mathematics. The various mathematical activities in this workbook use designs from The Courtauld Collection to introduce and explain important mathematical principles. The activities can be used in conjunction with the *Art and Maths in the Courtauld* learning resource or as stand-alone activities used to supplement existing lesson plans.

Teachers can access all elements needed to run the project – including the *Art and Maths in the Courtauld Collection* learning resource, lesson plans and this student workbook via our website or by emailing the Learning Department.

Email: education@courtauld.ac.uk
Telephone: 020 7848 1058
Website: www.courtauld.ac.uk/learn/

Francesca Herrick, Courtauld Alumni and Gallery Learning Educator, who has worked with the Collection for almost a decade wrote and edited this workbook.

IMAGES

Activity 1: Dish, Italy (Venice?), about 1530-50, Bronze with silver inlay, 45.9cm

Activity 3 & 16: Metalwork bag, Mosul, Iraq, Early 14th century, Brass with gold and silver inlay, 13.5x 19.2x 15.2x 22cm

Activity 3: Moulded dish or crespina with Cupid holding a basket of fruit, Circ 1540, Tin-glazed earthenware, 21cm

Activity 4: Workshop of Giorgio Andreoli, Dish with ornamental letter, about 1525, Lustred earthenware, 23cm

Activity 5: Moulded dish or crespina with Cupid holding a basket of fruit, 16th century, Lustred earthenware, 21cm

Activity 5: Lustred dish or piatto da pompa with one of the Magi, 16th century, Lustred earthenware, 41cm

Activity 6: Moulded lustred dish or tondino with rays and bosses, 16th century, Lustred earthenware

Activity 6: Dragon-spouted drug jar, Italy (Castelli), about 1520, Lustred earthenware, 25.3cm

Activity 7: Dish or tondino with a female martyr inscribed S.L., probably for St Lucretia, 16th century, Lustred earthenware, 23cm

Activity 11: Lustred ewer with scale and leaf design, 16th century, Lustred earthenware, 18.3cm

Activity 12: Lustred dishes or piatto da pompa with one of the Magi, 16th century, Lustred earthenware, 41cm

Activity 13 & 14: School of Islamic Geometry - http://www.sigd.org/resources/

Activity 14: Photograph credits Stephanie Christodoulou & Francesca Herrick

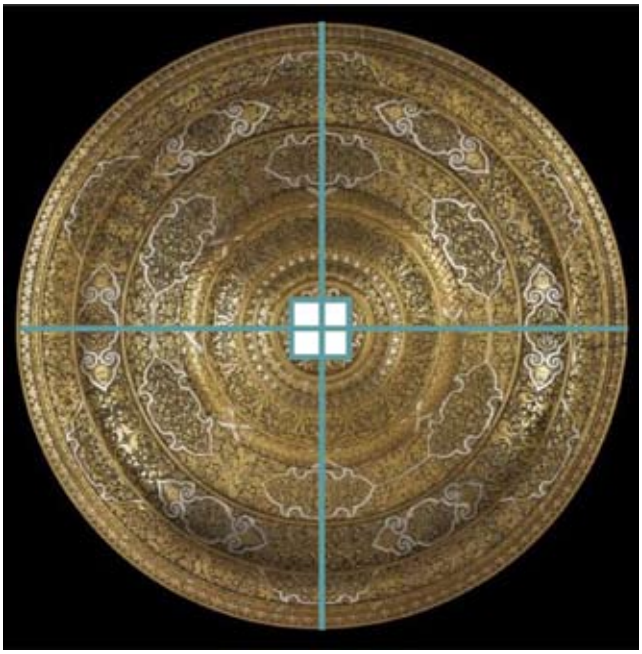
ACTIVITY 1:

ANGLES

Knowing how to measure angles and understanding the properties of certain shapes are important skills for making patterns.

This bowl was produced in Italy in the 1500s where inlaid metalwork from Egypt and Syria was often traded.

The craftsperson who made it was inspired by the rich decoration of Islamic metalwork. Parts of the design are highlighted out in silver.



Two **lines of symmetry** have been drawn on top of this design to create four equally sized **sectors** of a circle. These are known as **quadrants**.

What is the value in degrees of each angle marked with a small square? .....

How many degrees are there in a circle in total? .....
Don't forget to add the degrees sign

Another way to divide the plate is into 6 equally sized **sectors** of identical pattern.

Each angle measures 60°. How many angles are in a semi-circle?

.....

What do we call an angle smaller than 90°?

.....

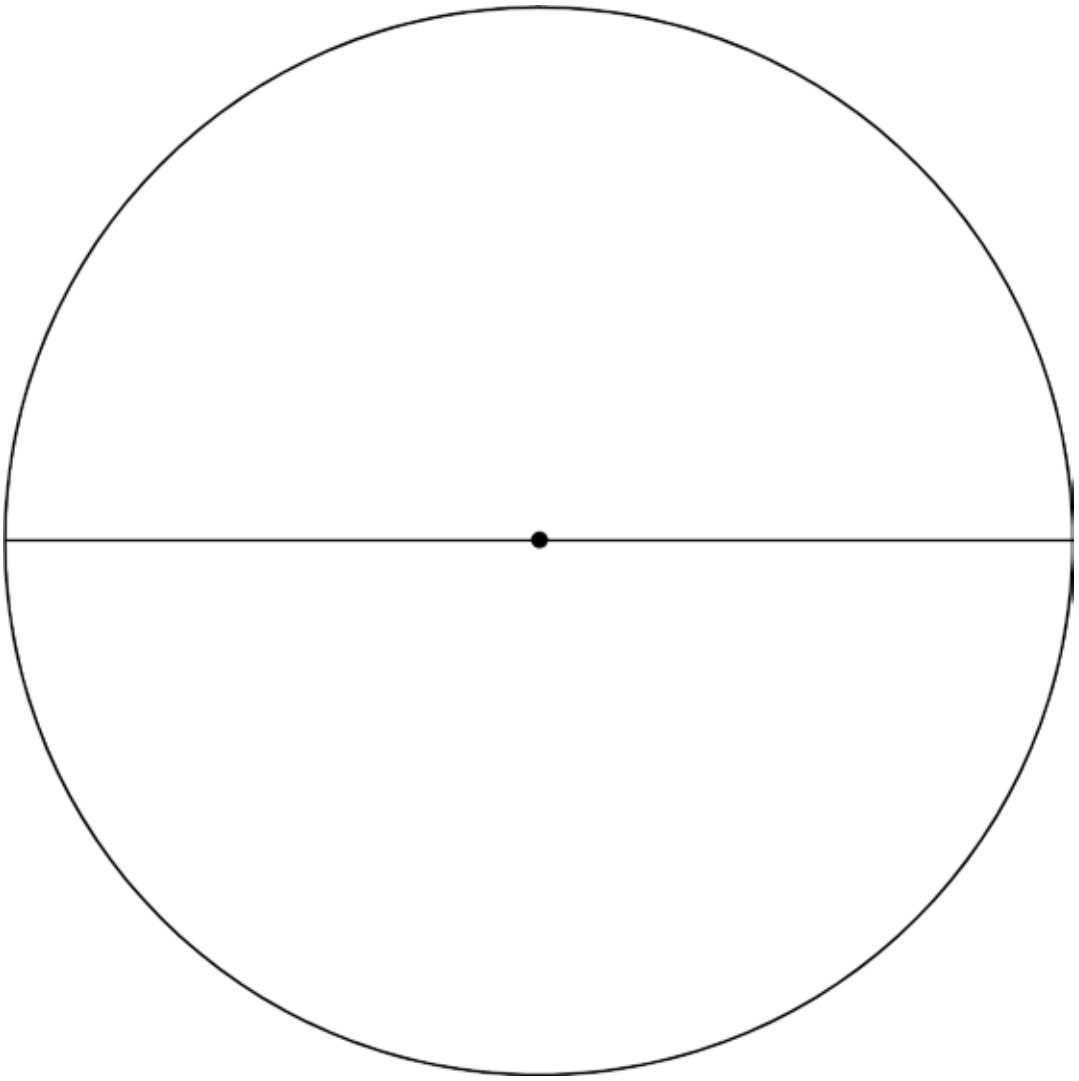
What do we call an angle larger than 90°?

.....

ACTIVITY 2:

PLATE TEMPLATE

Now see if you can divide the circle below into six equal angles and segments using a protractor and ruler. The centre of the circle is marked with a dot and one line has already been added.



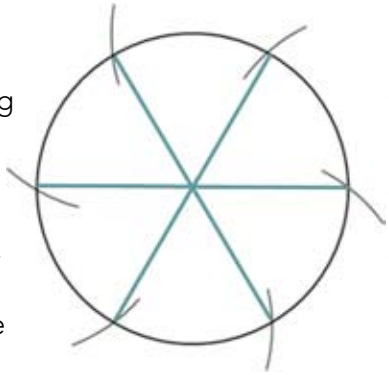
Decorate your plate with curvy shapes and flowing plant-like forms.

ACTIVITY 3:

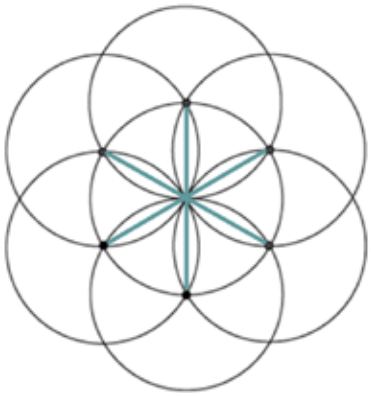
CIRCLES AND HEXAGONS

Your tutor will explain how it is possible to divide a circle into 6 parts using just a compass and ruler. You can try this back at school.

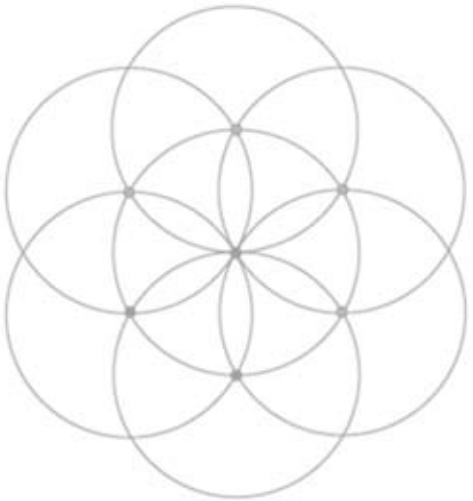
Draw a circle and place the compass point anywhere on the **circumference**. Keeping the compass open by the same length as the circle's **radius**, draw an **arc** and then use this as the starting point for drawing the next arc. Continue until you have drawn 6 arcs.



Draw a circle and place your compass point anywhere on the **circumference**. Draw another circle of the same size. Use the two **points of intersection** to draw two more circles. Continue in this way until you have a flower shape.

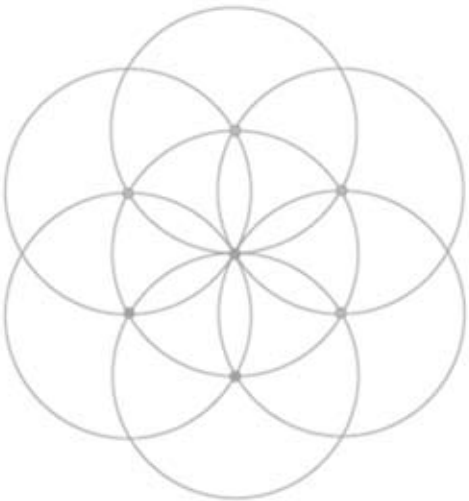


Choose which lines to go over in order to **make the six-petal design picked out in gold** on the Courtauld Bag. Use a coloured pencil of your choice.



There are some bigger pictures of the bag on the next page.

Now see **how many hexagons** you can make from the same group of intersecting circles.



THE COURTAULD BAG

ACTIVITY 4:

SYMMETRY

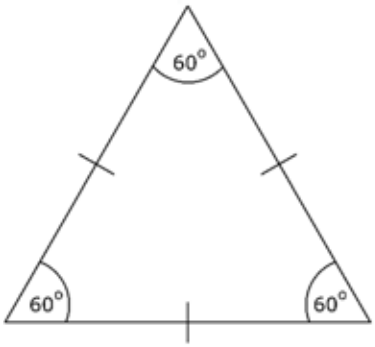
Symmetry can often be found in the designs produced by Islamic metalworkers and Renaissance ceramicists. It helped them to bring qualities of balance, order and unity to their creations.

A design has a **line of symmetry** if the two halves it divides are exact reflections of each other.

One line of symmetry has already been drawn on this dish made by Giorgio Andreoli in around 1525.

How many more lines are there in total? (use a mirror to test your answers).

Name the shapes below and add all of the lines of symmetry you can find for them.



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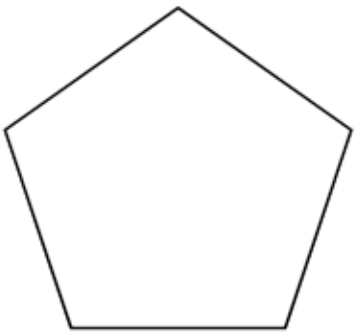

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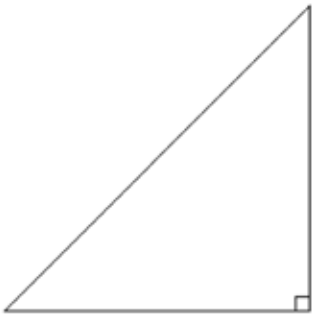

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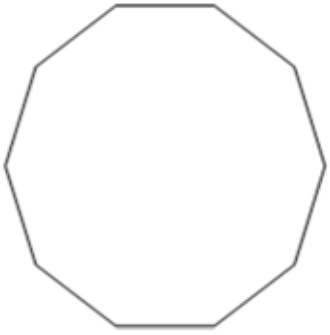

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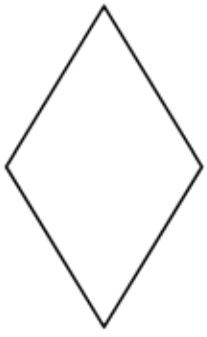

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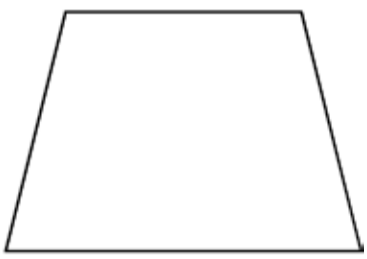

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ACTIVITY 5:

DIVISION & SYMMETRY

Make an octagon by folding along its lines of symmetry.

The tutor will give you a circle of paper.

Carefully fold this in half to make a **semi-circle** (180°).

Fold this in half to make a **quadrant** (90°).

Fold this in half to make an **octant** (45°)

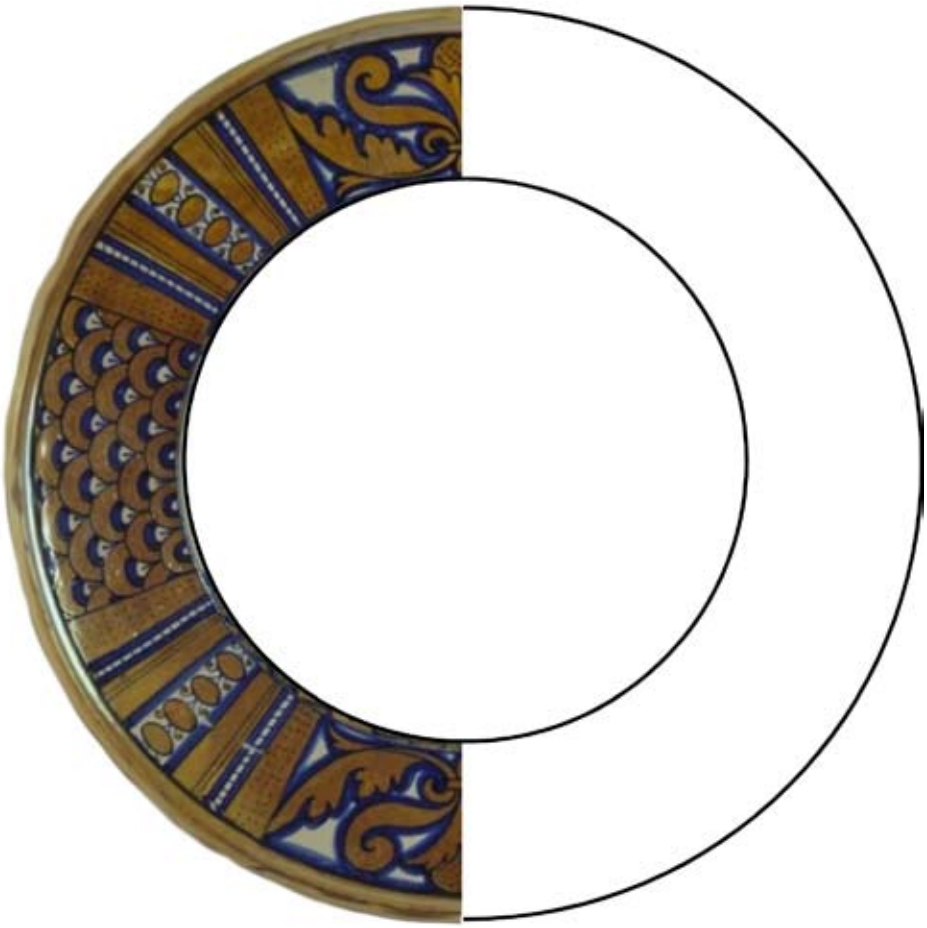
Open the circle back up and use a ruler and pencil to join the points where the fold lines meet the **circumference**.

Keep your octagon and decorate it with patterns from The Courtauld Gallery

Create a plate border:

Draw the **mirror image** of this plate design in the opposite space.

You can either do this by eye or by tracing and flipping over the original design.



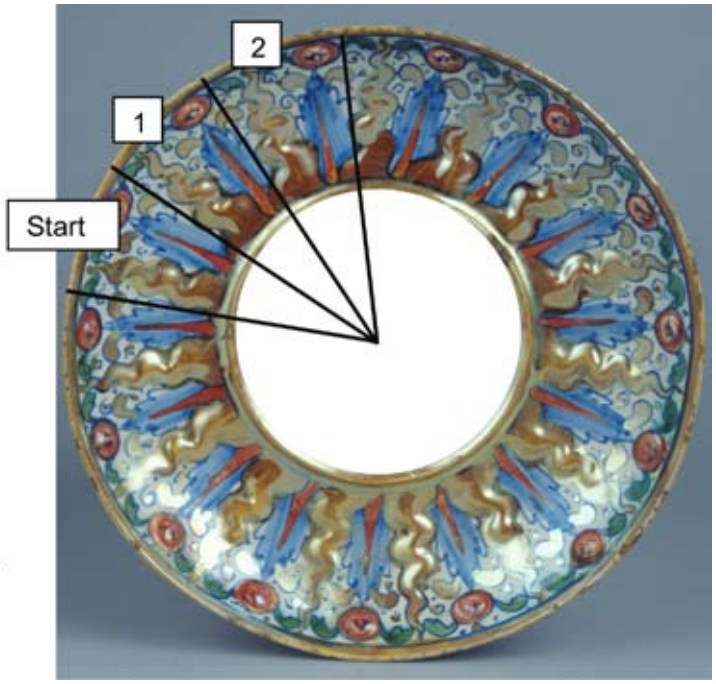
ACTIVITY 6:

ROTATION

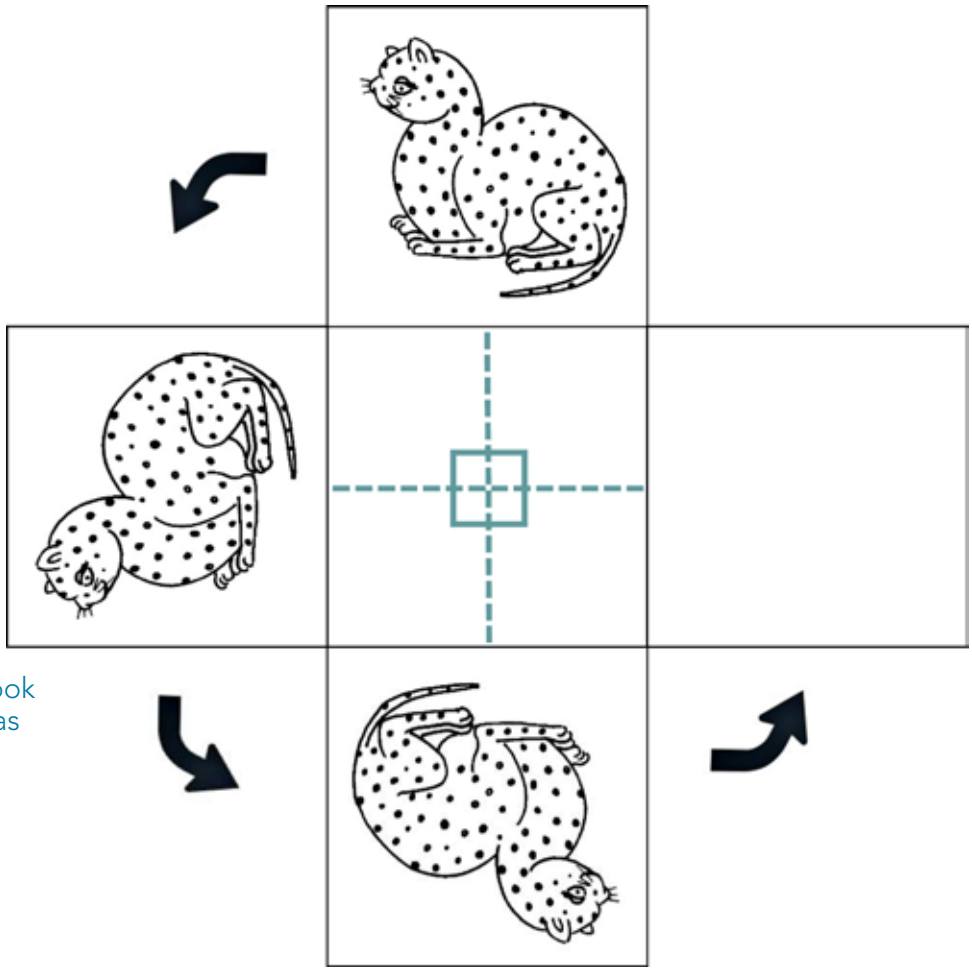
How many times has this motif been rotated to create the border?

Use a ruler to mark each rotation as the spoke of a wheel.

Two rotations are already marked. The slice-like portions of the circle are called **sectors.**



The spotted cat design below has been taken from a Majolica pharmacy jar.



How should the spotted cat look in the last rectangle when it has been **rotated 270° (3 x 90°) anti-clockwise?**

ACTIVITY 7:

DESCRIBING FEATURES OF CIRCLES

Let's find out how much we have learnt about circles. Label the following features of a circle:

Radius

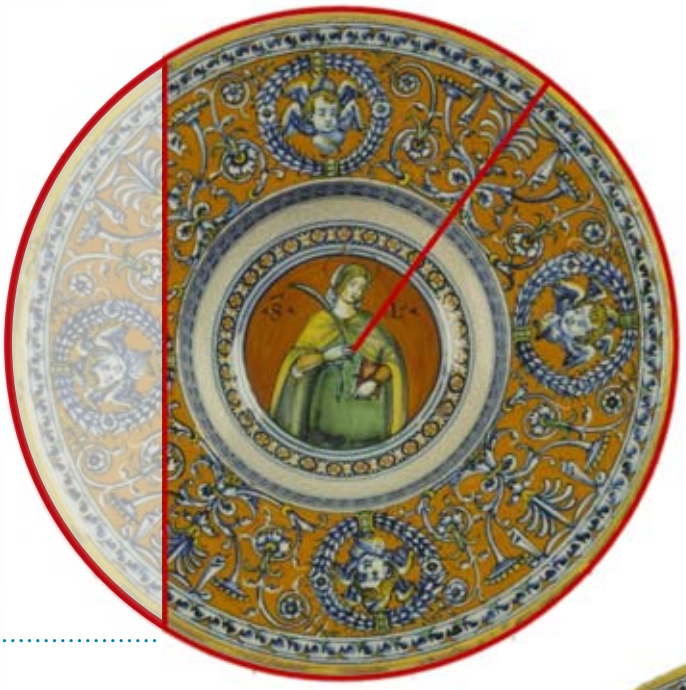
Diameter

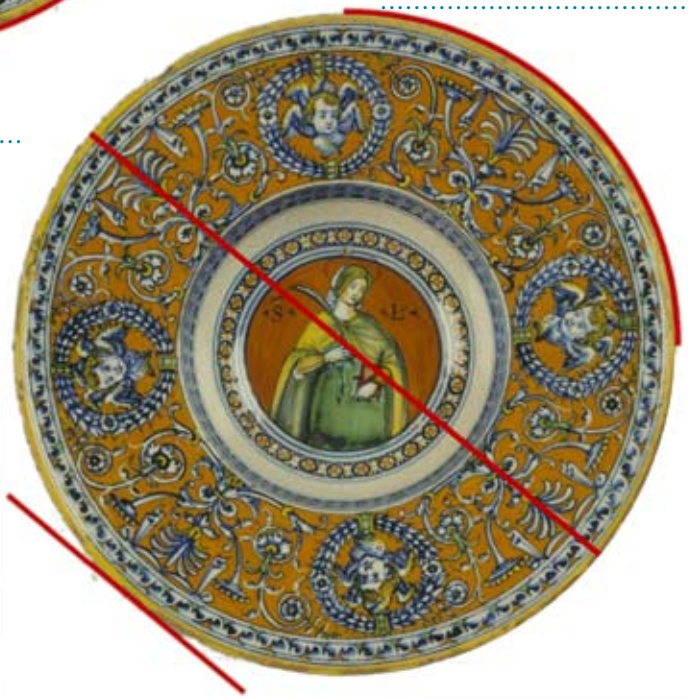
Circumference

Arc

Tangent (clue: from the Latin word tangere, 'to touch')

Segment (clue: think of a segment of orange)



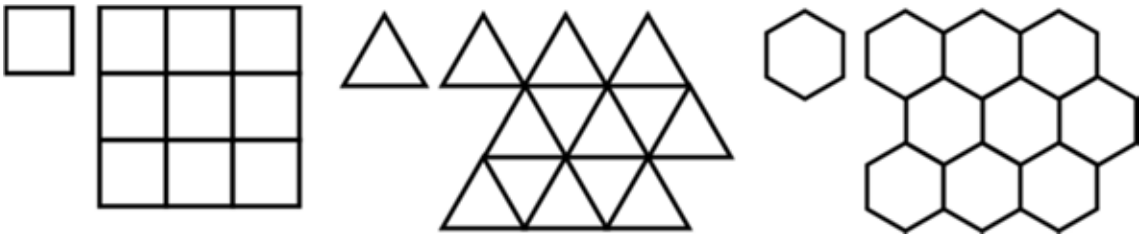


ACTIVITY 8:

TESSELATION

This describes when we cover a surface with a repeated pattern of flat shapes so that there are no overlaps or gaps.

It is rare that shapes will fit perfectly together. In fact this only happens in three situations (illustrated below). This is called **regular tessellation**. In most cases we will need to use two or more shapes to cover a surface without any gaps.

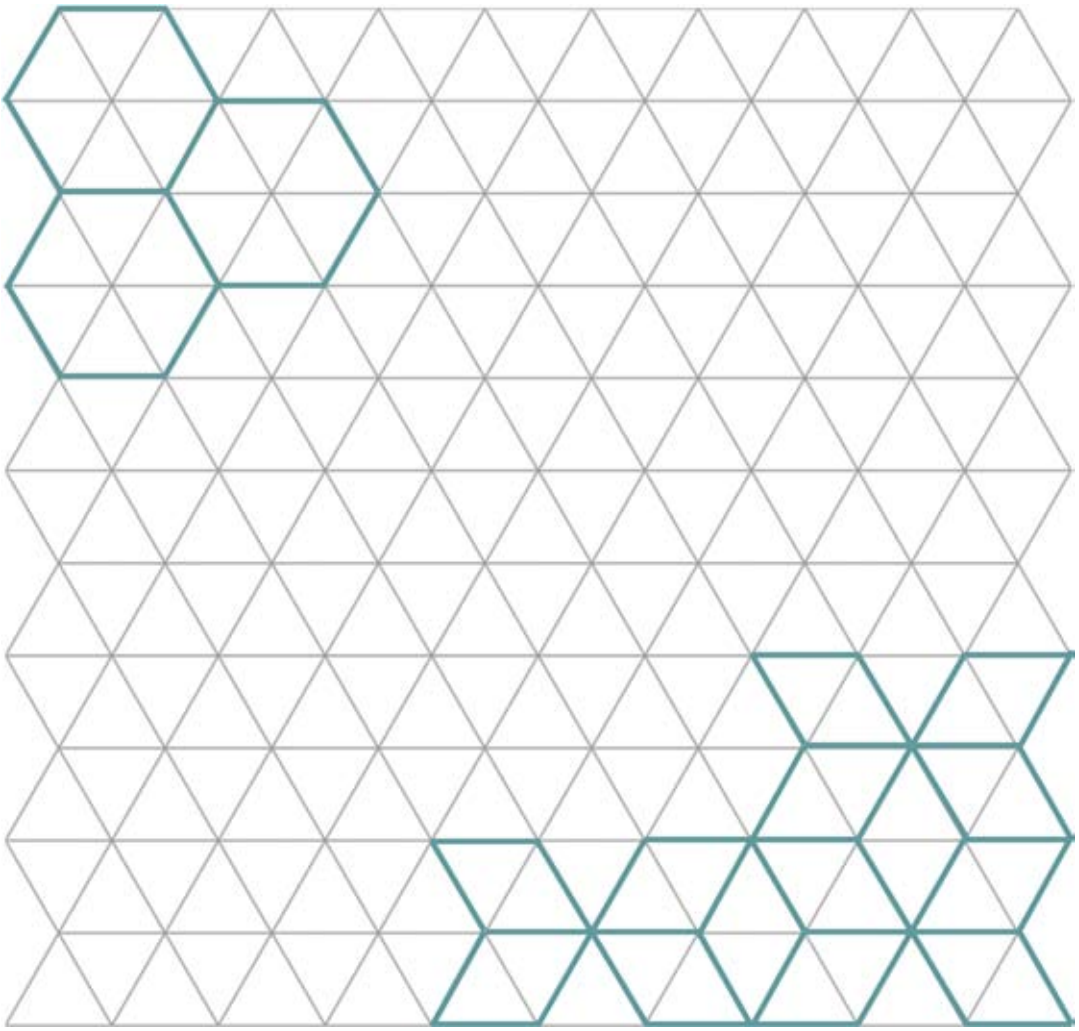


What do the above shapes have in common? (Clue: it may help to measure the sides).

DESIGNS WITH A TRIANGULAR GRID

See if you can continue the patterns.

Each side of a triangle measures 1.5cm.

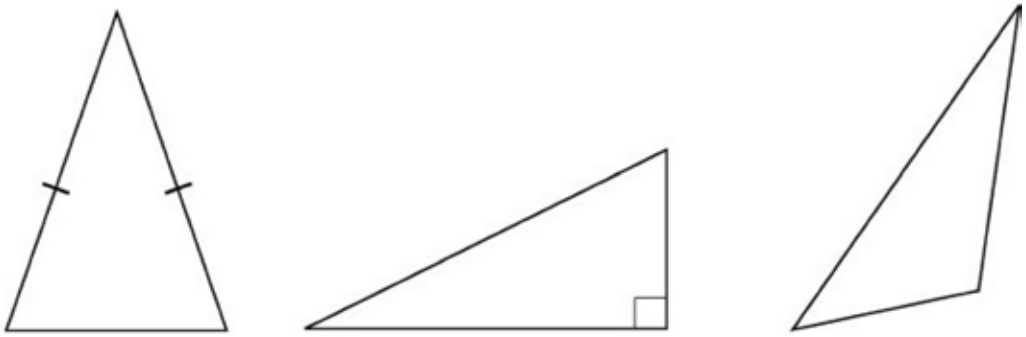


ACTIVITY 9:

TRIANGLES

POLYGONS are shapes made up of straight sides.

Equilateral triangles are **regular polygons**. Can you label the other main types of triangles? These are irregular polygons because not all of their sides are of equal length.



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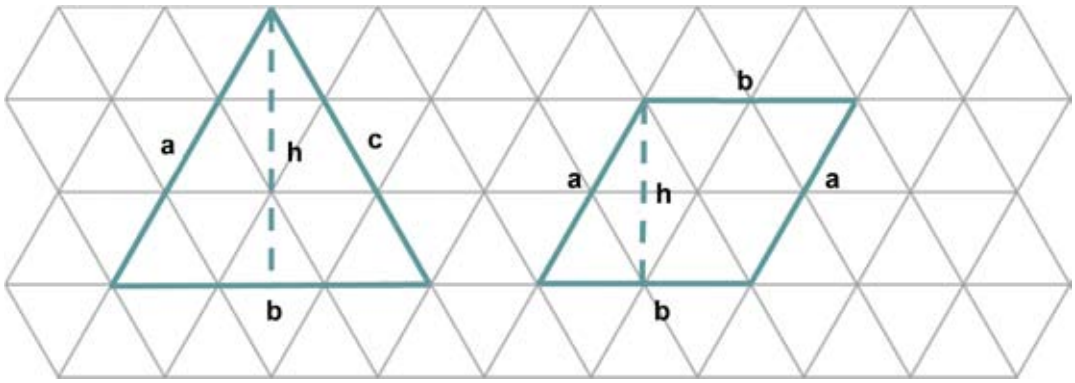
Measure and label the angles in each corner for all three triangles. They should all add up to the same total of degrees.

What is this number?.....

AREAS OF TRIANGLES AND PARALLELOGRAMS



Measure the **P**erimeter of the triangle P = a + b + c Measure the **A**rea of the triangle to the nearest 2 decimal places (you may use a calculator) A = ½ base x height	Measure the **P**erimeter of the parallelogram P = 2a + 2b Measure the **A**rea of the parallelogram to the nearest 2 decimal places (you may use a calculator) A = base x height

If you feel unsure about working with decimal places, see if you can still learn the formula for the area of a triangle and the formula for the area of a parallelogram.

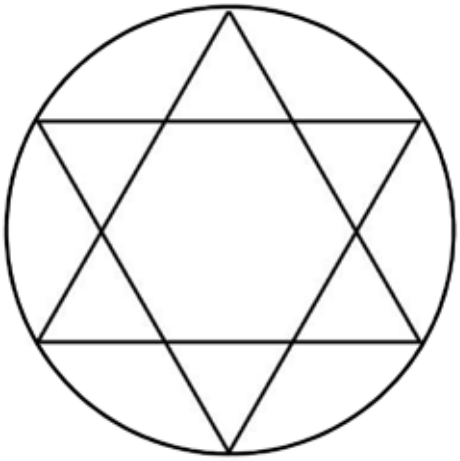
ACTIVITY 10:

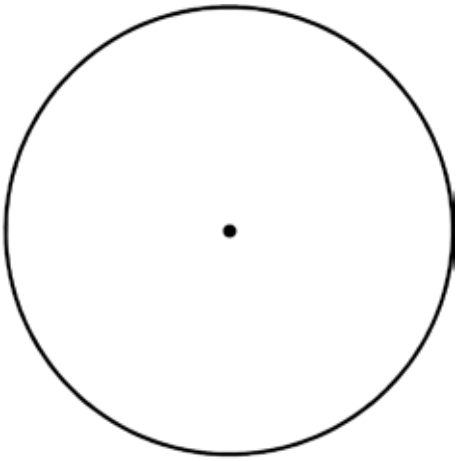
MAKING STARS

The same shapes and patterns appear in Islamic design in different counties. Ideas may have been shared through craftspeople travelling and through objects being traded. It is also possible that designers were simply experimenting with the same tools and construction lines so came up with identical patterns by themselves. Some of the earliest geometric motifs to be used in Islamic design were 6 and 8-pointed stars.

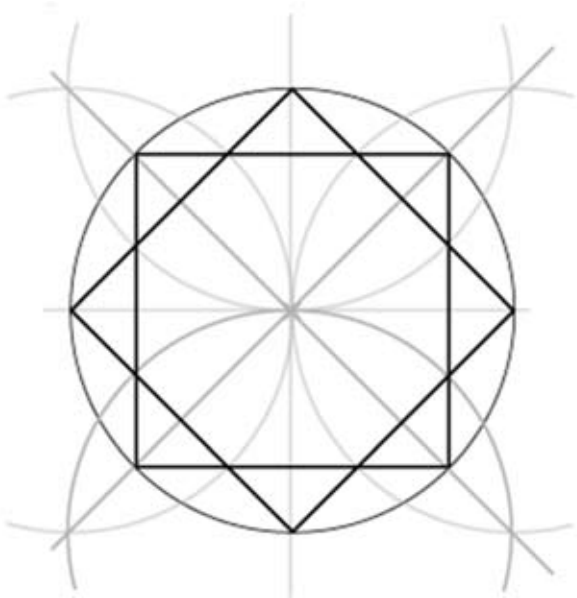
A 6-pointed star is easy to make. Draw 6 equally spaced **arcs** on the **circumference** of the empty circle (look back at Activity Sheet 3 – you will need to measure the **radius** of the circle). Join up every other point to make the star. How many equilateral triangles have you drawn?

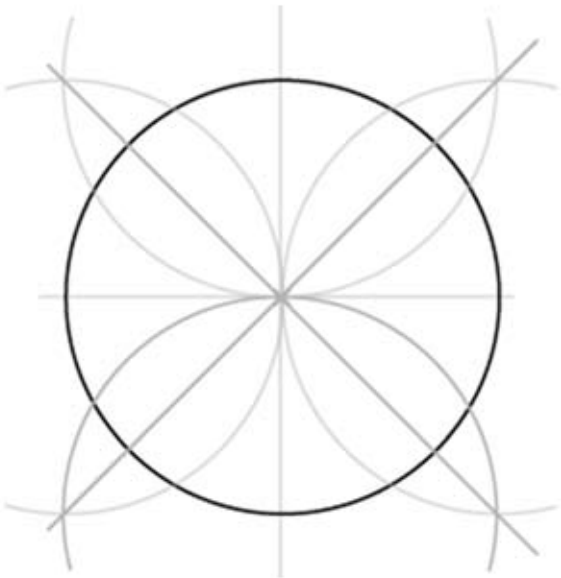
Go to page 14 if you get stuck and need a little help. Turn over to practise using a compass.





An 8-pointed star can be made by drawing two squares inside a circle.
See if you can join up the correct points on the construction lines below to create your own 8-pointed star.



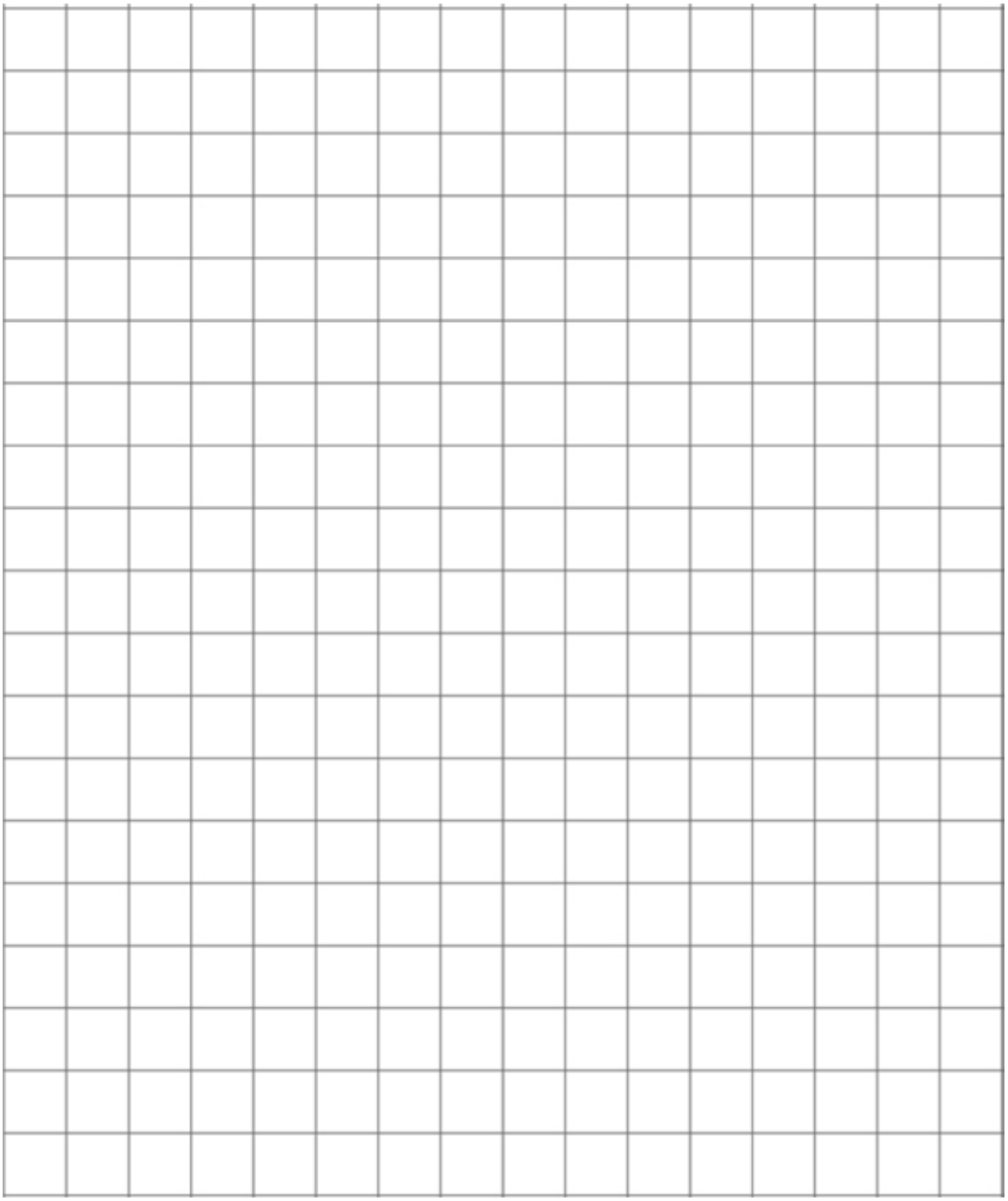


TIPS FOR USING A COMPASS

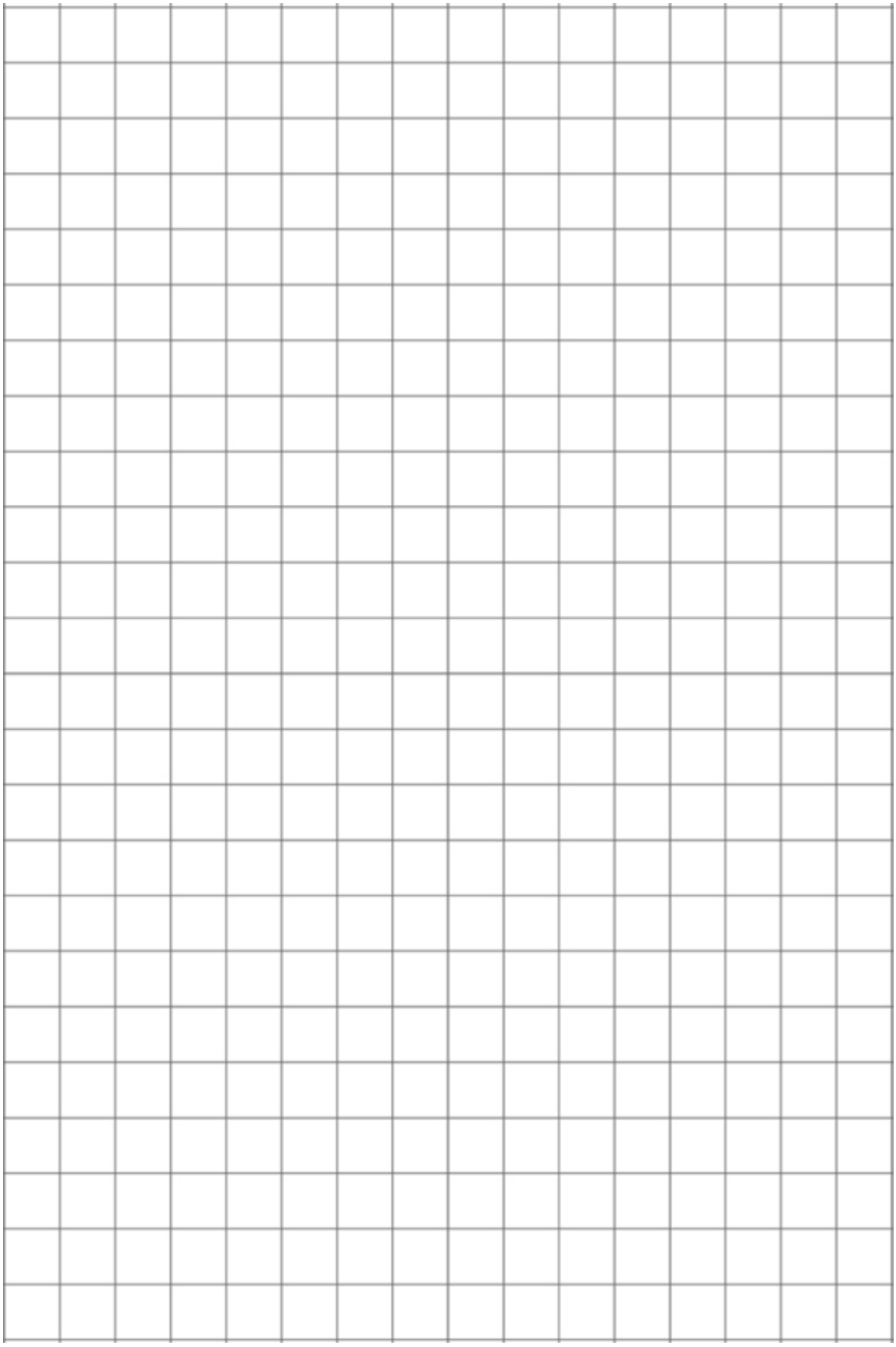
• When the two arms of the compass are placed together, the metal point and the tip of the pencil should just touch.

• Tighten the holder for the pencil so that it does not slip. It is easier if you use a pencil that is shorter than the compass itself.

• When drawing your circle or arc, only hold the plastic top of the compass. Do not touch any other part of the compass/ pencil or your radius may change in length.



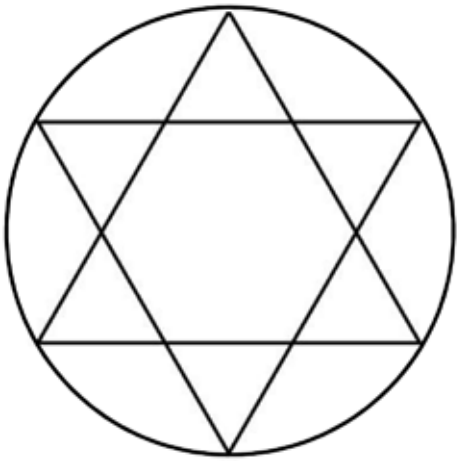
PRACTICE PAGE

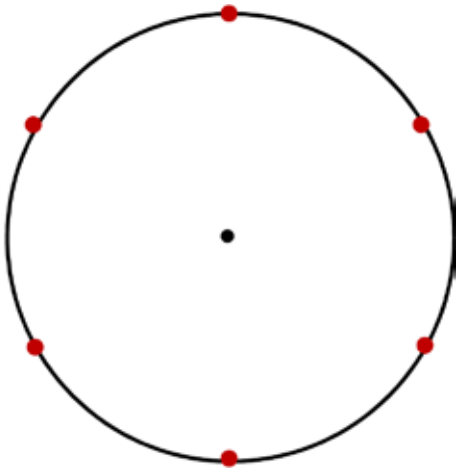


ACTIVITY 10 (with construction points)

A 6-pointed star is easy to make.

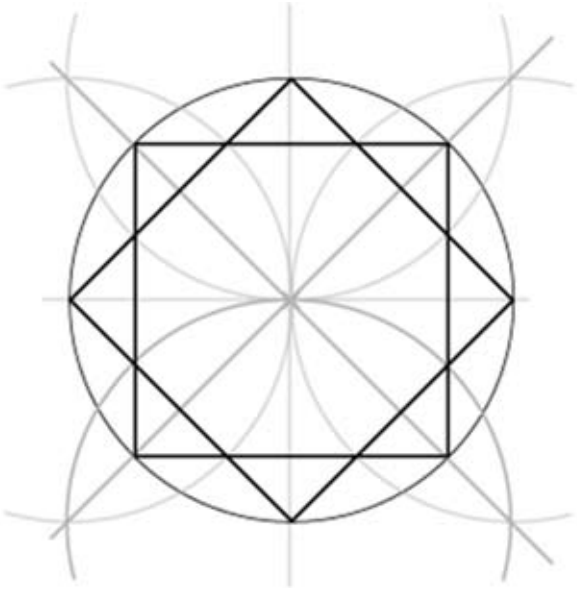
Join up the correct points to make the star. How many equilateral triangles have you drawn?

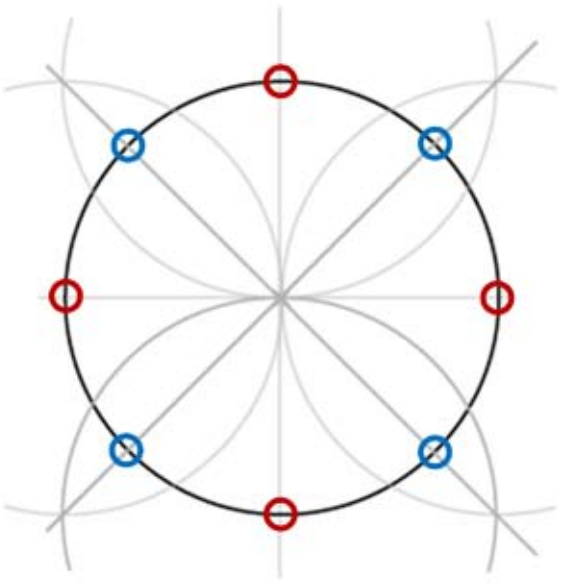




An 8-pointed star can be made by drawing two squares inside a circle.

See if you can join up the correct points on the **construction lines** below to create your own 8-pointed star.





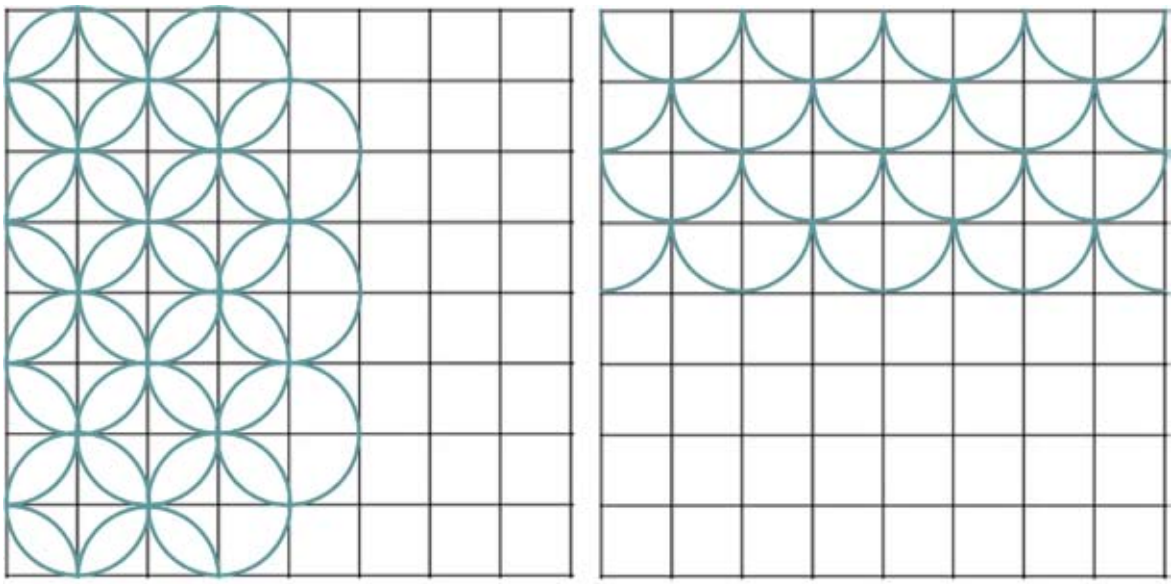
ACTIVITY 11:

DESIGNS WITH A SQUARE GRID

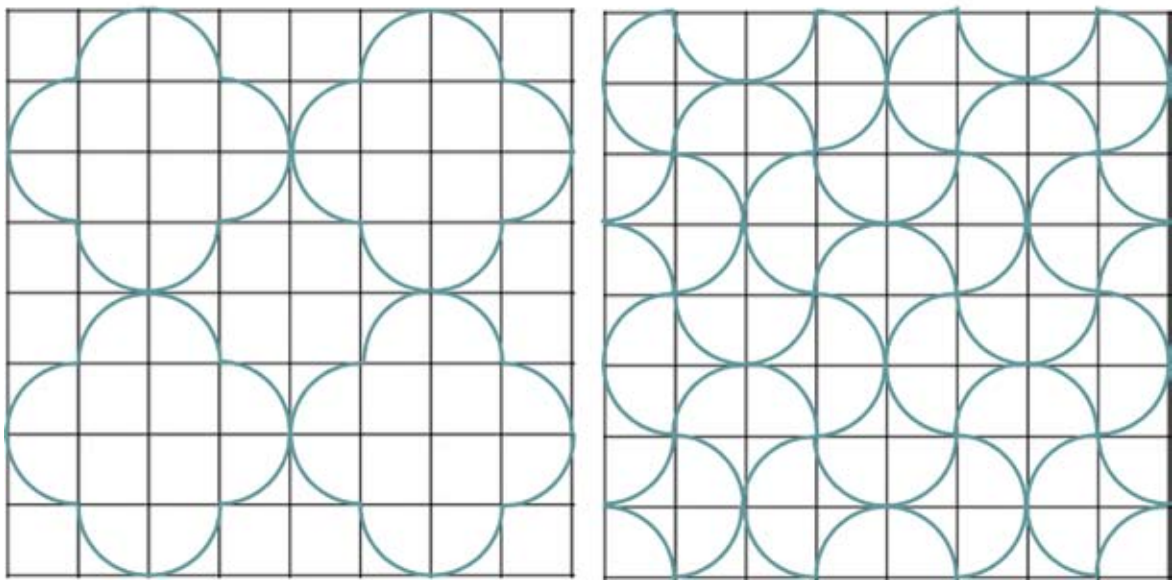
Scale or petal-like designs appear on all sorts of Majolica objects. Here are instructions to make similar designs using a square grid and circles.

Measure the height of a square on the grid below and open your compass by the same amount. The first design is made of full circles and the second design is made from half circles.

See if you can continue the patterns.



Customise the patterns below by colouring each one in a choice of two colours.



ACTIVITY 12:

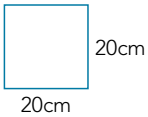
PERIMETER AND AREA OF QUADRILATERALS

A **QUADRILATERAL** is a polygon with four sides. The square floor tiles in the plate designs below are regular quadrilaterals because all sides are equal and all angles inside are right angles.

Shapes that have four sides, which are not all equal, and angles that are not all right angles, are called **irregular quadrilaterals.**

In the Renaissance era, wealthy Italian people would often have floor tiles in their homes and palaces made of Majolica. They would have to tread very carefully!

If the side of one of the tiles in real life measures 20cm what is the perimeter of the tile?



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What is the area of one tile (don't forget to use the correct units)?

.....

Imagine you are a Renaissance potter. How many tiles would you need to make by hand for a square floor which covers an **area of 4m²?** Show your workings.

.....

What would be the **perimeter of this room in cm?** Show your workings.

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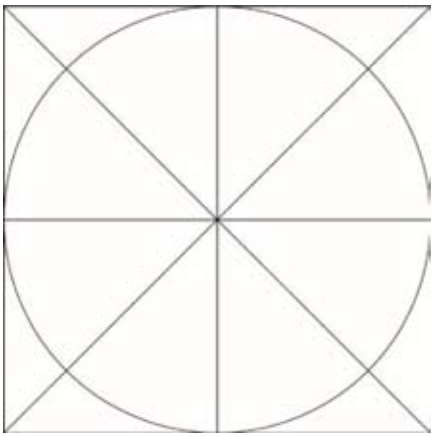
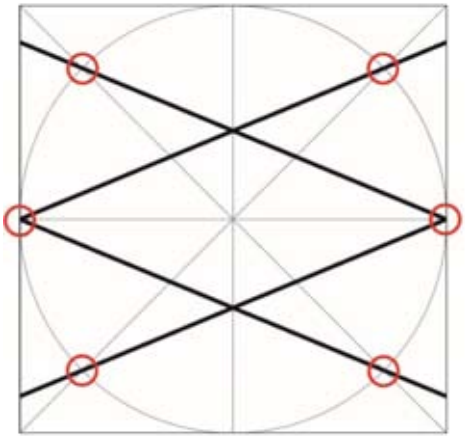
ACTIVITY 13:

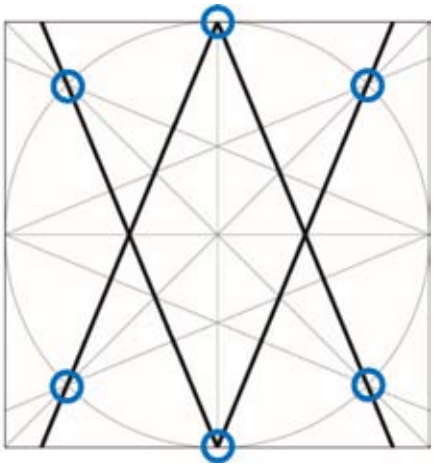
MAKING CONTINUOUS PATTERN WITH STARS

Here are the instructions to make a design that can be repeated and put together to make an infinite surface pattern. It is another version of the 8-pointed star.

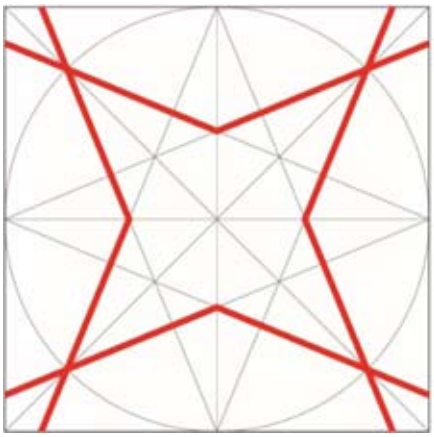


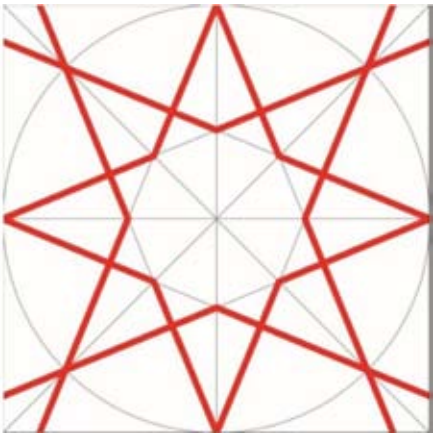
STAGE 1 • Begin by making a square 21 x 21cm (the width of a sheet of A4 paper).
• To find the centre point, fold/ draw diagonal lines between opposite corners.
• Fold/ draw a vertical line and a horizontal line through the centre point.
• Place the compass point on the centre and draw a circle with a radius of 10.5cm.





STAGES 2 & 3 • Draw the **construction lines** shown above using the **points of intersection** that are highlighted with coloured circles





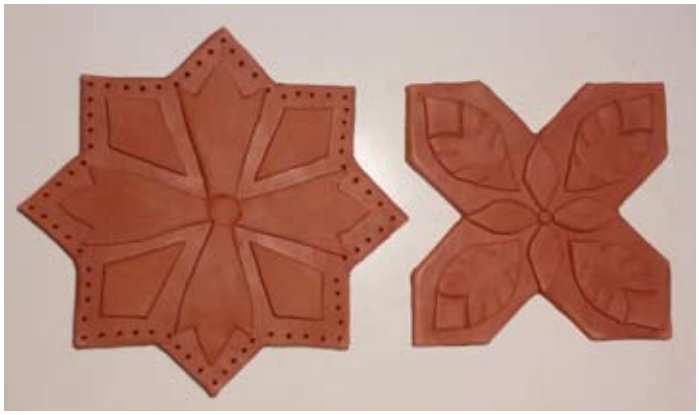
STAGE 4 & 5 • Go over the construction lines that you want to use in a coloured pencil

FINALLY • Lay a sheet of **transparent** acetate on top and trace your design using a ruler and coloured marker pen. Place your acetate sheet next to your classmates' designs and see what happens. You might like to display them altogether on a window.

ACTIVITY 14:

MAKING AN ISLAMIC TILE DESIGN

Here are the instructions to make an Islamic tile design with **semi-regular tessellation**.

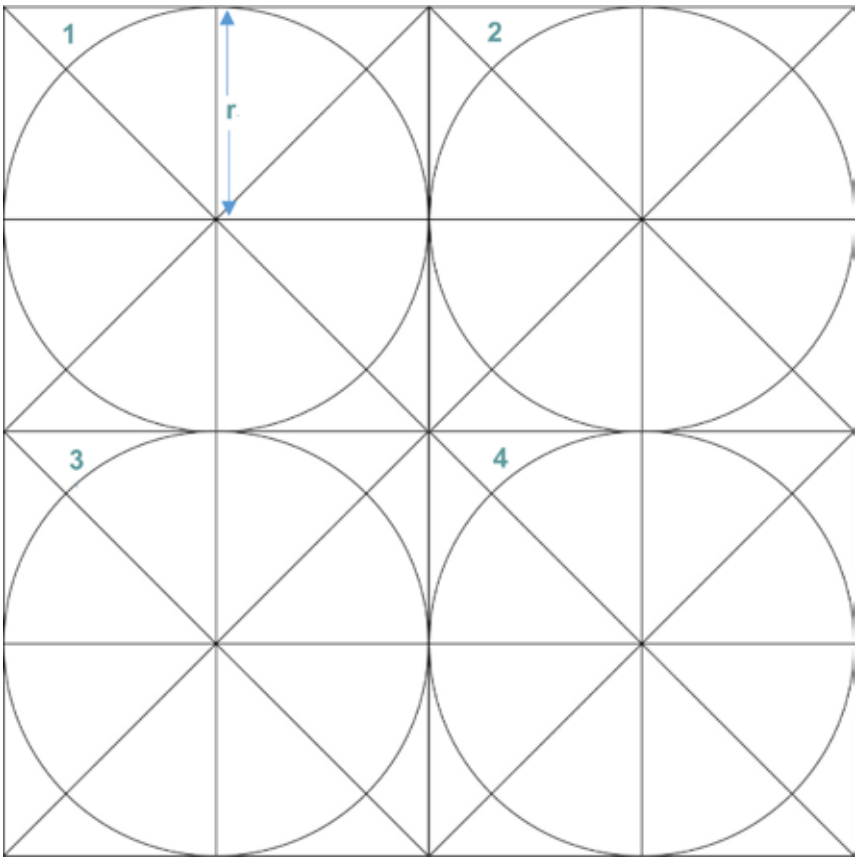


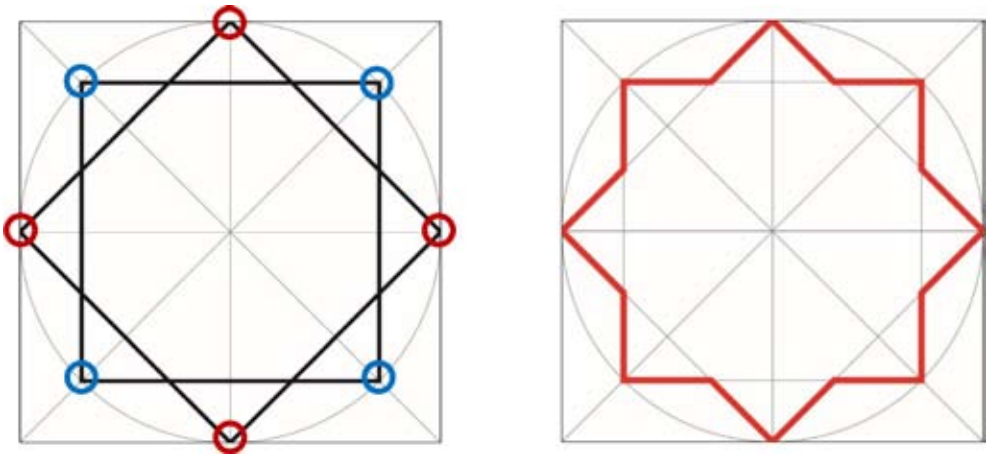
STAGE 1 Create a square grid and constructions lines.

Your teacher will give you a large square sheet of paper. Carefully fold this in half to make a rectangle. Fold this in half to make a small square. Open the paper back up and go over the fold lines with a ruler and pencil.

Your square should be divided into four equally sized squares (labelled 1–4). Draw diagonal lines between the corners of each squares as you did for Activity Sheet 10. Add vertical and horizontal lines through the centre points where the diagonals meet.

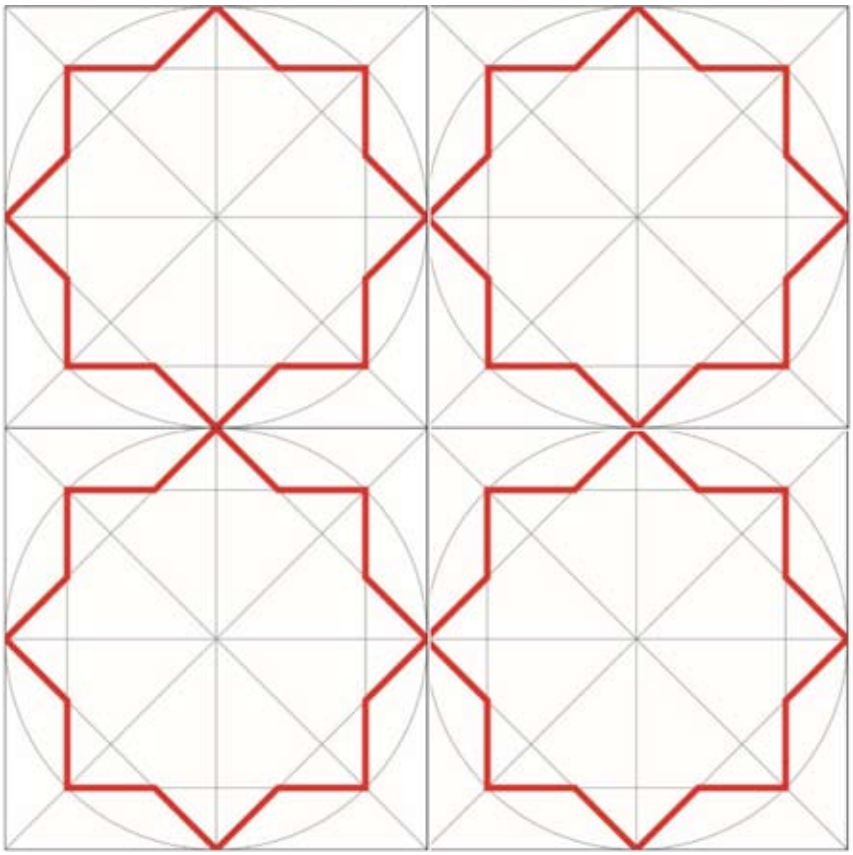
Measure the distance marked **r** on the diagram below and open your compass by this amount. Place your compass point in the centre of each square and draw a circle.





STAGE 2: Draw an **8-pointed star** inside each circle on your grid

STAGE 3: Go over the star's **outer construction lines** in a coloured pencil



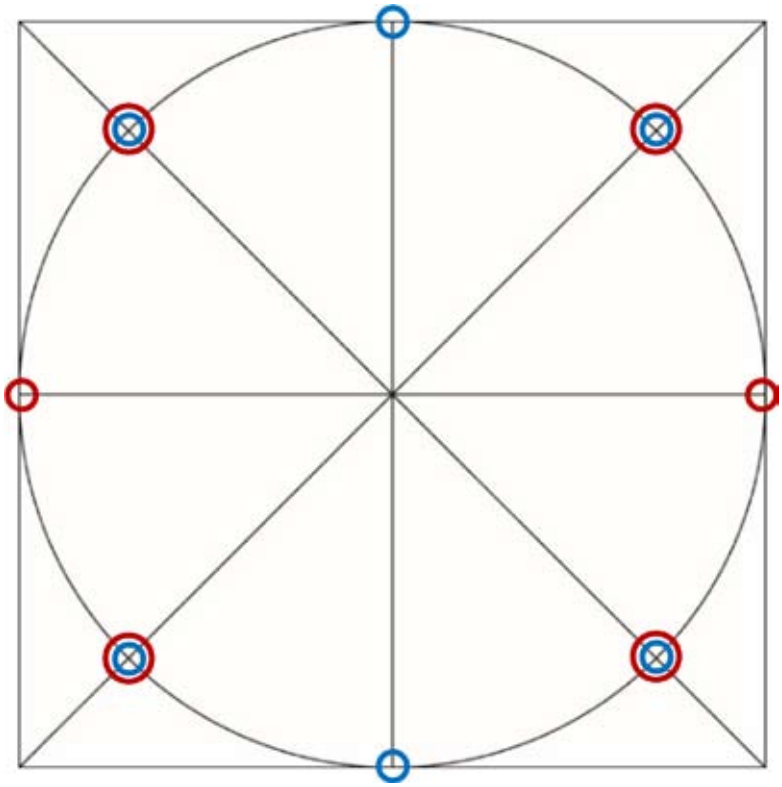
STAGE 4: You should have created four star shapes and one cross shape in the middle. These will be the templates for making your tiles.

Roll out a small amount of clay out so that it is **8mm thick** (use a ruler to check) on top of a star or the cross. Cut out the shape in clay using a plastic knife. Cut out one star and one cross to begin with.

STAGE 5: You can decorate your tiles by **carving** a design into them, **adding** clay decorations or **impressing** patterns into them.

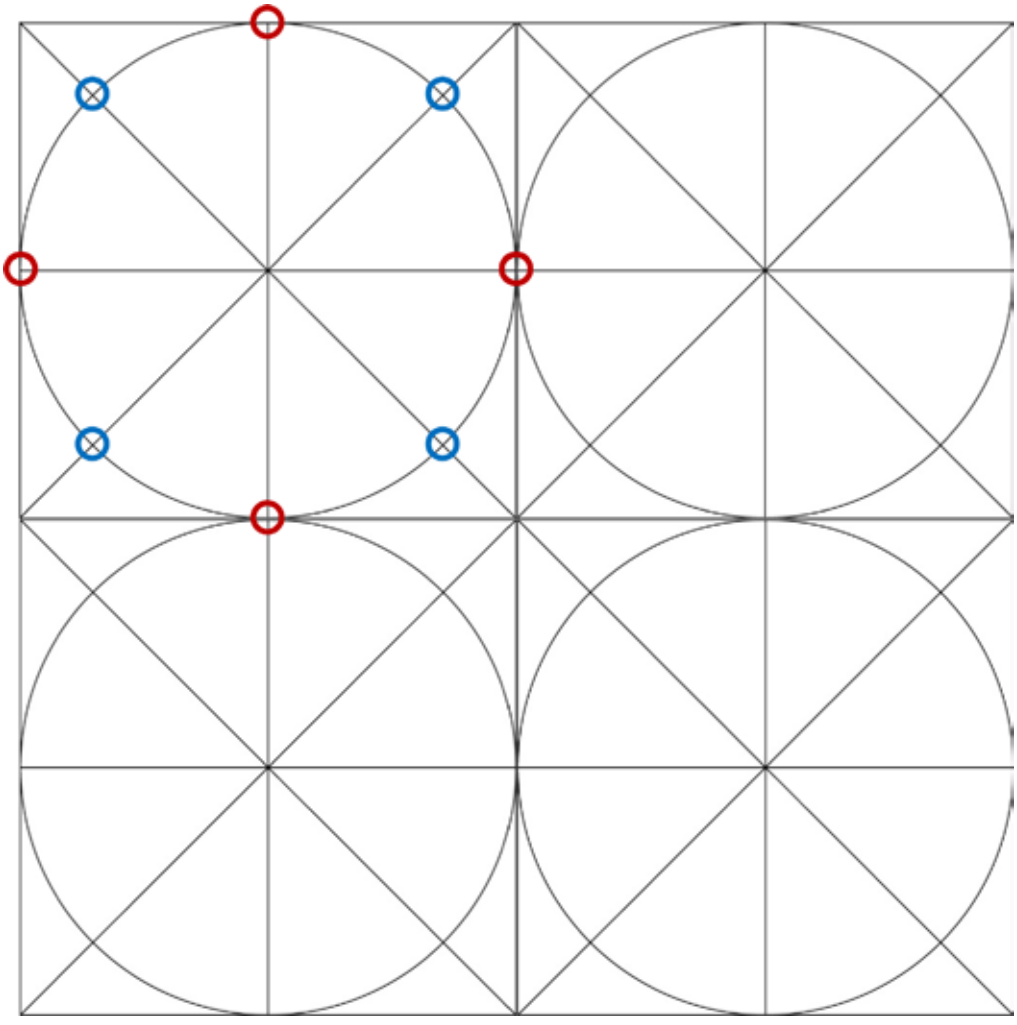
OPTIONAL TEMPLATE FOR ACTIVITY 13

Teacher instructions: This template can be photocopied and doubled in size to create a square 21 x 21cm (the same width as the A4 acetate)



OPTIONAL TEMPLATE FOR ACTIVITY 14

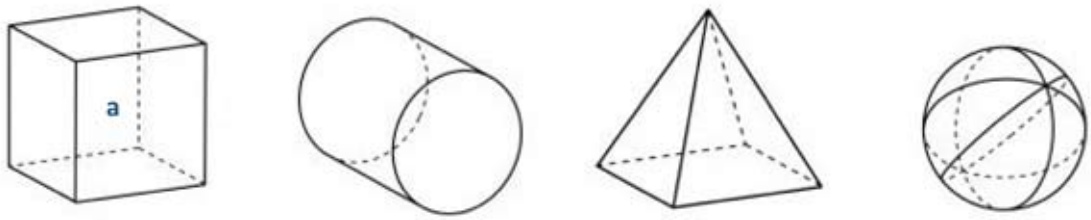
Teacher instructions: Photocopy and enlarge on an A3 sheet of paper to the desired size.



ACTIVITY 15:

AREA AND VOLUME (ADVANCED LEVEL)

Name the 3D shapes:



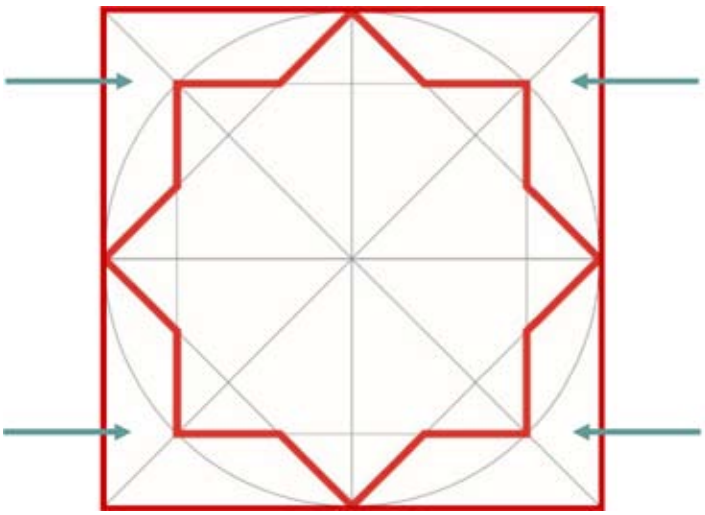
How much clay do we need for our tiles? .....

Volume is the amount of space an object takes up.

The volume of shape a is found by multiplying the area of the square cross section (**l**ength x **b**readth) by the height (**h**).

V = l x b x h

Measure one side of the squares you made for **Activity 14** (this tells you the length and breadth for the formula above).
Our tiles should be 8mm (0.8cm) high/ thick.
.



These four corner pieces make a cross

What is the volume of clay in total needed in **mm³** to make one star shaped tile and one cross shaped tile? (you may use a calculator)

.....

What is the volume of clay needed in **cm³**? (you may use a calculator)

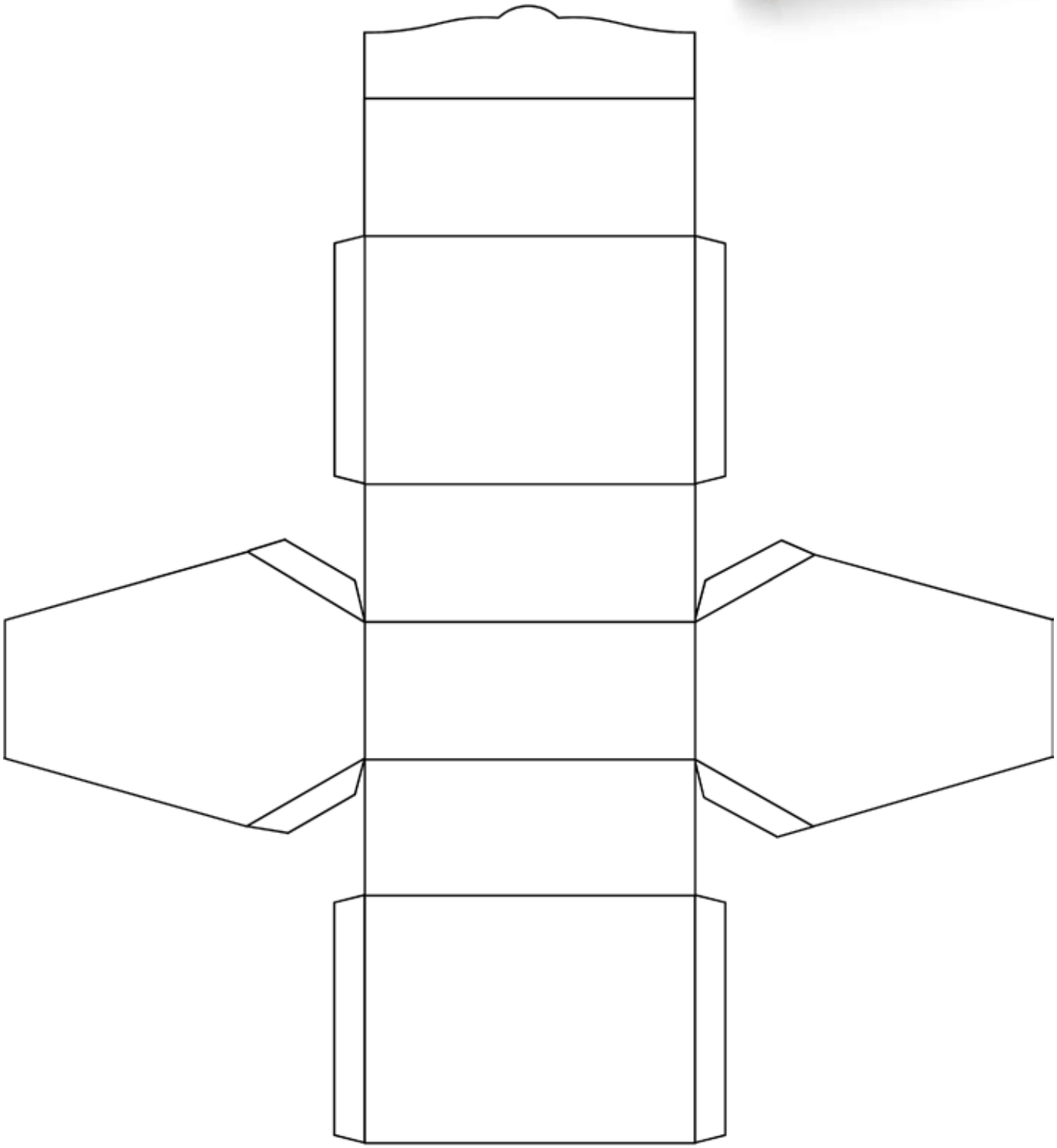
.....

ACTIVITY 16:

AREA AND VOLUME – NET DESIGN

Decorate and cut out your own version of the Courtauld Bag.

Or, you could ask your teacher to photocopy and enlarge the net design.



LEARNING RESOURCE
CREATIVE CONNECTIONS
ART AND MATHS PROJECT WORKBOOK

First Edition

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