INTEGRATED UNIT 2: GEOMETRY IN THE ALHAMBRA

Key words

tile gap pattern break-into overlaps cover
surface polygon tessellation vertex angle
shape axis rotation translation reflection

Let's begin the unit watching the video "La Alhambra y las matemáticas"

Now you know a few things about the relationship between the Alhambra and maths, but you need more information to be ready for this unit:

TASK 1: Investiga un poco sobre la relación entre las matemáticas y la Alhambra, y busca la respuesta a estas preguntas:

1) ¿Por qué los árabes usaban tanto la geometría para las decoraciones de sus palacios?

2) ¿Cuál es el número áureo o de oro? ¿Por qué es tan importante?

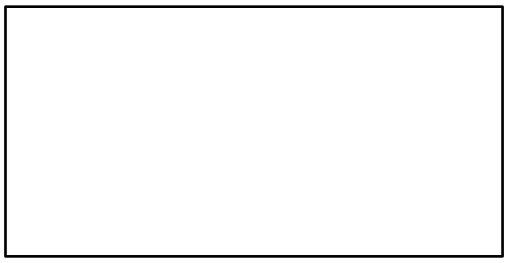
3) ¿Qué es un rectángulo áureo? ¿En qué lugar de la Alhambra podemos encontrar rectángulos áureos?

You can begin your research with the following links:

https://nosvamosagranada.wikispaces.com/ALHAMBRA
https://prezi.com/fzuzzwuuje8i/la-alhambra/
https://prezi.com/qruaat8s78nc/las-matematicas-y-la-alhambra/

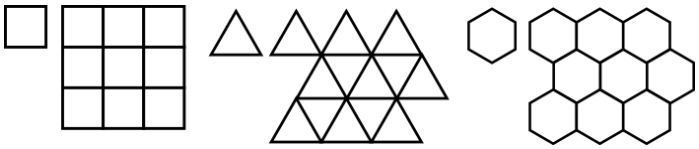
TASK 2: WHAT IS A TESSELLATION?

- **Activity 1:** Cover the space on the following rectangle by drawing polygons. Do it your own way. The only rule is to not leave gaps between the polygons.

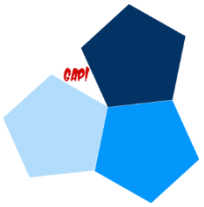


- Each piece of this drawing is a tile.
- For practical reasons, for example, when you have to cover the ground with paving stone, it is easier and cheaper to get all the tiles having the same shape.
- When you cover a surface with a pattern of tiles with no gaps or overlaps, this is called a tessellation or tiling.

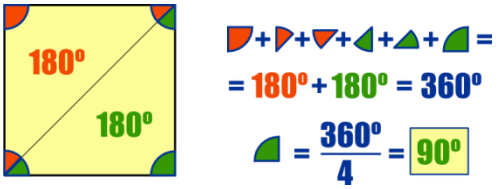
What about if you use regular polygons? You can make tessellations by using squares, equilateral triangles and hexagons.



- **Activity 2:** Is it possible to cover a surface with other regular polygons?



- To answer that question you have to measure the interior angle of a regular polygon.
- There is no need to use any measuring tool to get that.
- Just use maths and the following rule: "the interior angles of a triangle add up to 180°".
- Besides, you can divide a polygon into triangles so, for example, to work out the interior angles of a square...

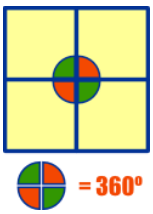


- What are the interior angles of the regular polygons? Complete this table and figure out a general rule.

Shape	Sides	Break it into triangles	Sum of Interior Angles	Each Angle
Triangle	3		180°	60°
Square				
				
Hexagon				
Octagon				
...	...	...	...	...
Any Polygon	n			

So the general rule is:

So what happen if we get together regular polygons to make a tessellation?



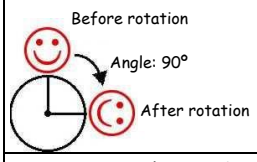
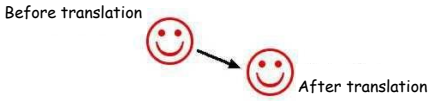
- The addition of the interior angles of the polygons that share one vertex must be 360º.

Then it is impossible to use any other regular polygons but squares, equilateral triangles and hexagons because the only ones whose interior angles are divisors of 360º are equilateral triangles (60º · 6 = 360º), squares (90º · 4 = 360º) and hexagons (120º · 3 = 360).

- **Activity 3:** Geometric transformations

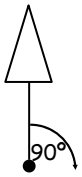
Let's watch this video: Colin Dodds - Geometric Transformations (Math Song)

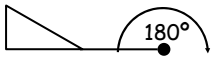
These are transformations:

ROTATION	TRANSLATION	REFLECTION
		
"turn it 'round"	"shift it left, right, up, or down"	"copy it across an axis of symmetry"

Answer the following questions about geometric transformations:

1) Rotate these shapes by the indicated angle clockwise:

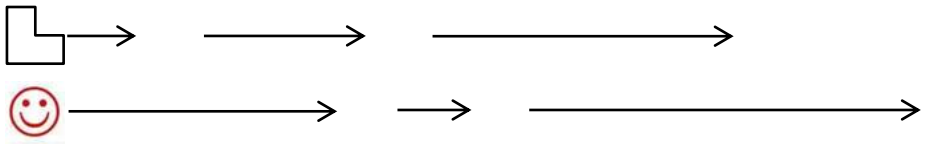




2) What do we need to rotate an object?

3) What do we need to translate an object?

4) Translate these shapes by the indicated vectors:



5) What do we need for a reflection?

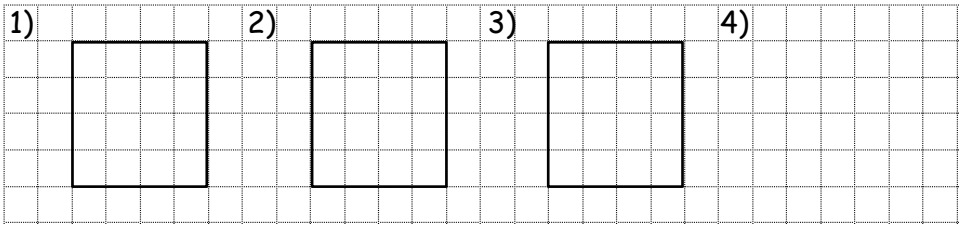
6) Reflect these shapes by the corresponding line of symmetry:

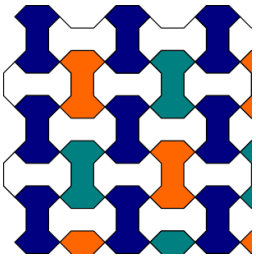
TASK 3: WHAT TESSELLATIONS CAN WE FIND IN THE ALHAMBRA?

The ancient artisans knew the restriction about the regular polygons and tried to make prettier tessellations by using different colours or making some distortion to the original tile and repeating it alongside the whole surface.

- Activity 1: "El hueso nazarí"

Take a look at this video to find out how the "hueso nazarí" is constructed and repeat the construction (http://concurso.cnice.mec.es/cnice2006/material105/Mosaicos/hueso.htm):





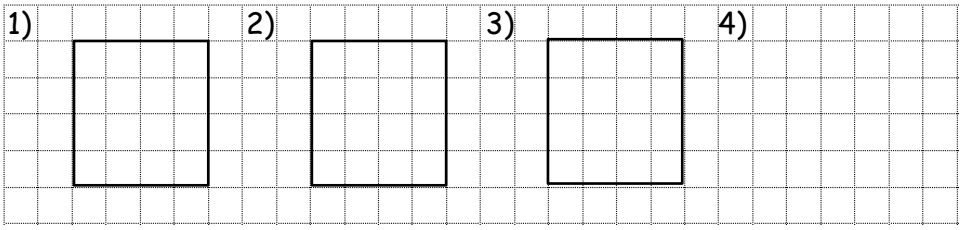
Draw the bone using the pattern on your grid and colour it to your own liking.

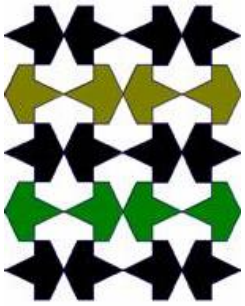
- Activity 2: "El avión nazarí"

You can see the construction of the plane in this link:

http://concurso.cnice.mec.es/cnice2006/material105/Mosaicos/avion.htm

Now it's your turn:

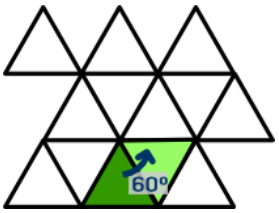




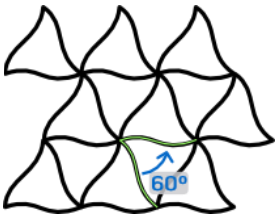
Draw the plane using the pattern on your grid and colour it to your own liking.

- Activity 3: "La Pajarita"

For the third tessellation we use a property of an equilateral triangle: it has rotational symmetry by 60°, that is, you can turn an equilateral triangle by 60° and get the same shape. If you translate that property to our triangle tessellation:



Any transformation you do to one side of a triangle can be replicated by rotating it 60° and there'll be no gaps.



Here you can see the construction of the "pajarita":

http://concurso.cnice.mec.es/cnice2006/material105/Mosaicos/pajarita.htm

Draw mosaics using the pattern and colour it to your own liking: