Mathematical route

Mathematics constitute an axis in the education that is studied by pupils for years, however, citizens are likely to have problems finding mathematics in their daily life.

One form of discovering the mathematics that surround us is by proposing a route in the students' environment in which we can further explore mathematics and teach the concepts in a practical-based way.

1. ROUTE 1: Mathematics in the city. Part 1

In the present section, we will get to know the following aspects:

- Shapes
- Numbers
- Logos

1.1 Shapes

In the school, flat shapes prevail, but in our urban environment we can observe multiple types of shapes. Let's see some examples.

The ground: on the ground/soil of the city we can observe a huge quantity of patterns composed by shapes such as circles, triangles, rectangles.

Exercise 1: *Locate a soil/ground with a geometrical pattern and describe its composition.*

Signs: in the streets of a town or city we can easily observe circles, triangles, hexagons and octagons in traffic or road signs.

1.2 Numbers

There are plenty of numbers that surround us in the city: the numbers placed in the house entrances, hours (when we check the time), temperatures, etc.

Exercise 2: *Find an example of number in the streets.*

Exercise 3: *If a clock in the streets show that it is 14:17 (or 14:53), ¿can this be written as 14,17 (or 14,53)?*

1.3. Logos

In general, trademark logos have well studied shapes due to the brands' interest in people remembering their logos. With this purpose, many have geometrical elements that are simple and easy to remember.

Exercise 4: *Locate a geometrical pattern in the ground/soil and describe which elements appear.*

ROUTE 2: Mathematics in the city. Part 2

In the present section, we will explore the following aspects:

- Statistics
- Scales
- Urban furniture with geometrical development

1.1 Statistics

Nowadays, many cities take steps to monitor all kind of data. We can see, for example that estimates are taken and are useful to obtain the average flow of cars that circulate in a street during one day or how many people visits the centre of the city or a specific building along a month/year.

These estimates are carried out from a few measures that are previously done in the streets and the purpose usually is to improve the organisation of the city.

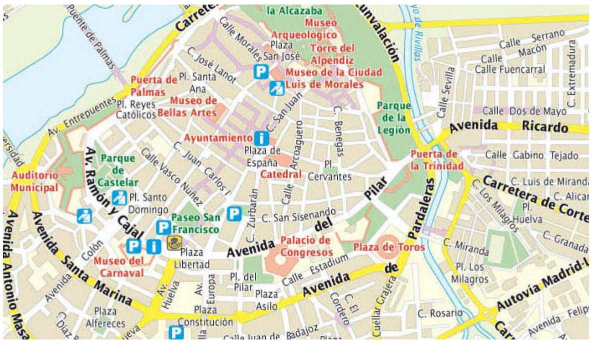
Exercise 1: *Locate yourself in front of a traffic light where traffic jams are formed, try to count how much time the green light is on and the number of cars that are stopped in that traffic light. Once this is done, calculate the car average number that are stopped in the traffic light each time.*

How much time the traffic light should be on so, there weren't any cars stopped in there? Which is the amount (average) of cars that should not remain there to avoid traffic jams?

1.2 Maps

In the cities, the first example of scale we can find are the map of the cities, we can see how the tourism offices

En las ciudades el primer ejemplo que encontramos de escalas son los planos de las ciudades, podemos ver como en las oficinas de turismo de las ciudades entregan planos que muestran la ciudad a escala para que los turistas puedan orientarse.



According to the scale that it is shown in the map, we will be able to figure out the real measure between both points in the real life.

For example:

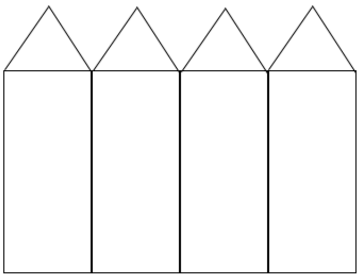
1/2500 cm indicates that each cm of the map corresponds to 2500 cm in the real life.

Exercise 2: *If in a map there is a distance of 20cm between two spots and the scale of such map is 1/3000, ¿Which is the real distance between the two spots?*

Exercise 4: *Find something that is in a scale compared to another element.*

1.3 Street/urban furniture

We can see in the street furniture elements the different items that compose it. Let's see an example.



In this case, the telephone booth is composed by 4 triangles and 4 rectangles.

Exercise 3: *Find two elements from the urban Street furniture and draw the elements that compose it. For example, analyse the following image.*

ROUTE 3: Measures

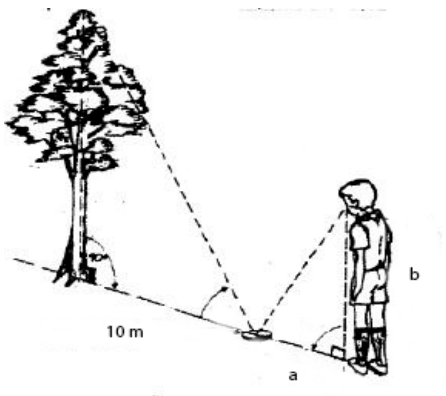
In the present section, we will get to know the following aspect:

- How to measure the height of a building
- Areas and volumes

1.1 Measure the height of a building

Sometimes we are not sure how tall a building or other elements are, and unfortunately, we cannot measure that with a tape measure. To face this problem, we can apply two different methods:

- **First method:**
  Place a mirror on the floor and then, a person gets away from the mirror until he/she can see the highest point of the object to be measured, as it is shown in the following image.



$$\frac{a}{b} = \frac{distance\ from\ the\ mirror\ to\ the\ tree}{tree's\ height}$$

After that, it is necessary to measure the distance from the mirror to the tree, know the height of the person that is looking to the mirror and the distance between the mirror and the person who looks at the mirror.

Therefore, the final height of the tree, clearing the previous equation is:

$$tree's\ height = \frac{b}{a} * distance\ from\ the\ mirror\ to\ the\ tree$$

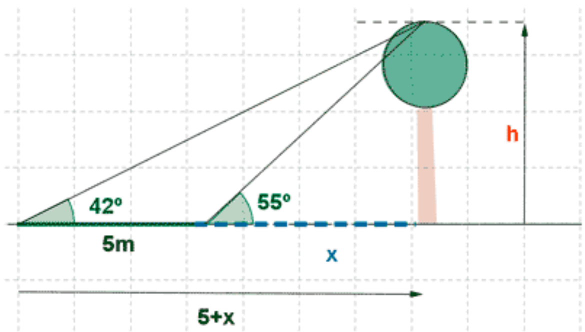
- **Second method:**

  If the distance remains unknown until measuring, then you need to use the angles that are formed using the definition of the tangent.

$$tg(\propto) = \frac{leg\ opposite\ angle}{contigous\ angle}$$

According to this method for calculating the height of a tree which we do not know how to calculate the distance to its base, we need to take to measures and know the distance between them. This way, we will be able to obtain a system of equations to discover the height. An example would be:

Según este método para calcular la altura de un arbol del cual no podemos calcular la distancia hasta su base necesitamos hacer dos medidas y conocer la distancia entre ellas. De esta forma podemos obtener un sistema de ecuaciones para obtener la altura. Un ejemplo sería:

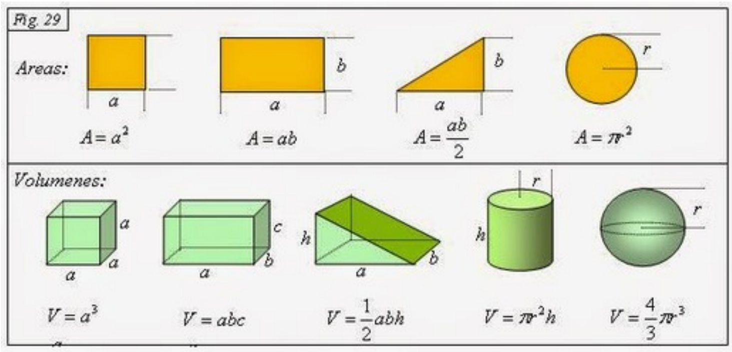


$$\left.\begin{array}{l} tg\ 55^\circ = \dfrac{h}{x} \\ tg\ 42^\circ = \dfrac{h}{5+x} \end{array}\right\} \left.\begin{array}{l} h = x \cdot tg\ 55^\circ \\ tg\ 42^\circ = \dfrac{h}{5+x} \end{array}\right\} \text{Resolvemos por sustitución.}$$

Exercise 1: *Calculate the height of two elements using both methods.*

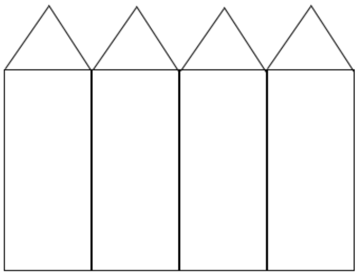
Exercise 2: *(More difficult) Obtain the height of an element that it does not have its base on the ground. For example, a statue on a pedestal.*

1.2 Areas and volumes



The elements that we find in the real life, in general, are figures composed from other figures. An example are the figures that we see in the previous image. Taking that into account, we are going to divide the elements that we cannot find in figures which we do not know how to calculate the area and the volume with the objective to get to know its area or volume.

For example, the area of a telephone booth would be the sum of its surfaces area: in this case, there are 4 rectangles and 4 triangles.



Exercise 3: *Calculate the area and the volume of three random objects that you find.*

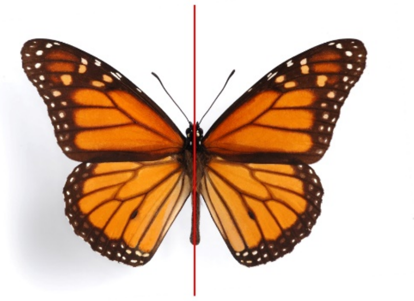
ROUTE 4: Mathematics in nature

In the present section, we will see the following aspects:

- Symmetry
- Parables
- Golden number and Fi number
- Spirals: sunflower or snails.
- Geometrical shapes in nature.

1.1 Symmetry

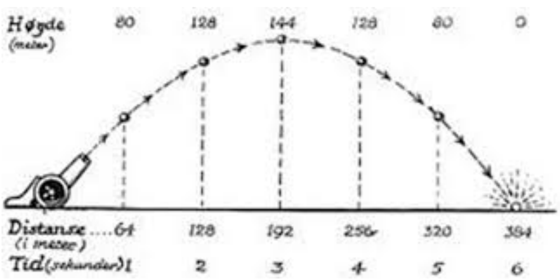
Nature shows us countless examples where to observe symmetry in both axis. Let’s see, for example, in the first photo we can notice the symmetry with regard to the x axis and in the second photo the symmetry is in the y axis.

Exercise 1: *Find two examples of symmetrical positions along the axes.*

1.2 Parables

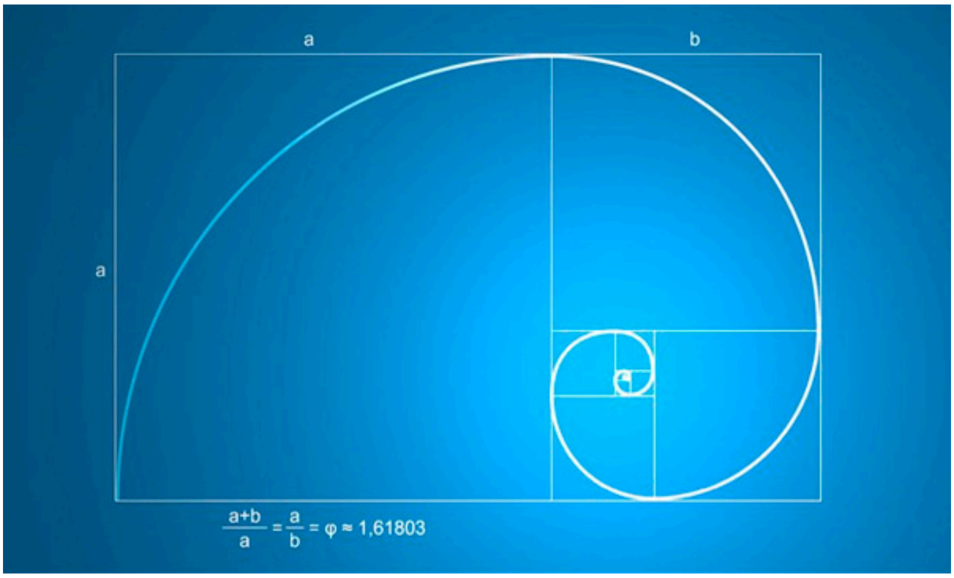
Along our life, we can observe several parables in plenty of places. The launch of a projectile/missile or specific buildings would be examples.



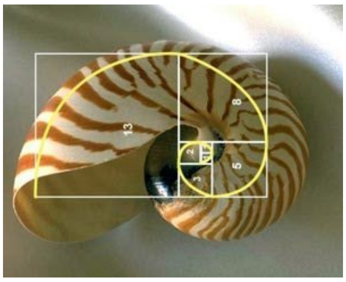
Exercise 2: *Find two examples of parables in nature.*

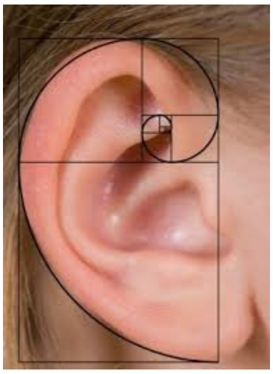
1.3 Golden Number

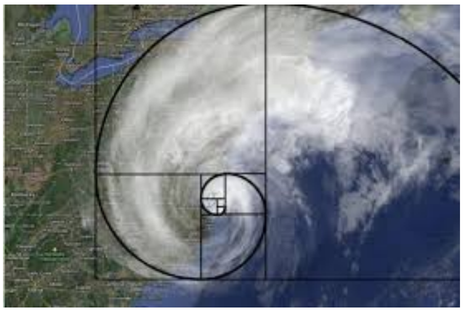
The Golden Number (also called Fi Number) has been known for ages and it is associated to beauty and nature. It is associated to the Greek letter "phi" (ϕ) and its approximated value is 1.618033. This is an irrational number, so it encompasses countless decimal numbers and not periodical numbers.



This proportion appears in countless places, buildings, in the growing process of plants, proportions of the human body, etc. Some examples of it are:







It is represented in the swell-known spiral of Dudero (Renaissance painter) that it is composed by the Golden rectangle and it can be found in the formation of shells of many molluscs.

Exercise 3: *Locate an element which contains the spiral of Dudero.*

1.4 Geometrical shapes in nature

At a first sight, it can seem that only humans are able to create geometrical shapes, however we can also observe that nature creates plants, bugs, etc. with almost perfect geometrical shapes and now, we will see some examples.

- A pentagon in the Ipomoea flower

- Hexagon in the beehives

Exercise 3: *Locate some poligon, geometrical form or a star in plants, fruits, etc. (Hint: you can cut the fruit in halves or even some flowers, if we draw lines from end to end of the petals, they can show as things).*