# Greek geometry 1

(by Ksenia Shalonova)

**Practical lessons from ancient geometers**. We are going to learn of the contribution from two ancient Greeks, Pythagoras and Thales. Both visited Egypt to gain understanding.

## Right-angled triangles

Pythagoras' theorem connects the side lenghts of right-angled trianges. Can you come up with some right-angled triangles with whole numbers for side lengths? This may give you a clue how they made right angles in Ancient Egypt using only a rope.

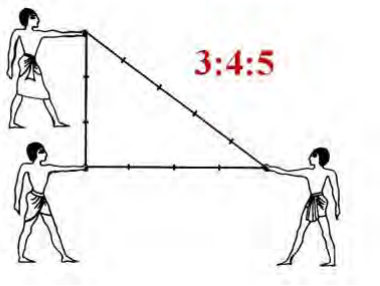
Suppose you want to make a badminton court in your garden.

- How will you make right angles using a rope? How many people would you ideally need to construct it?
- How many poles would you need to draw a long straight line (you can stick poles in the ground)?
- How will you check in the end that your quadrilateral is a rectangle?

# Solution

This sesssion can be carried out in the classroom. But it can also be outside, enabling the students to make practical measurements, e.g. in the school playground. In the later tasks they can measure the height of the building or construct a rectangular shape on the terrain. Teachers may need to provide more contextual scaffolds to give them starters for working on similar triangles.

The ancient Egyptians could make right-angled triangles using a rope which was knotted to make 12 equal sections. This is called the 3-4-5 method.




It seems that ancient Egyptians were using the 3-4-5 method before Pythagoras! Pythagoras managed to prove the theorem.

How would you draw a straight line on the terrain? *(Answer: you will need three poles).*

How do you check if your quadrilateral is a rectangle? *(Answer: measure diagonals with the rope - they should be equal).*

# Greek Geometry 2

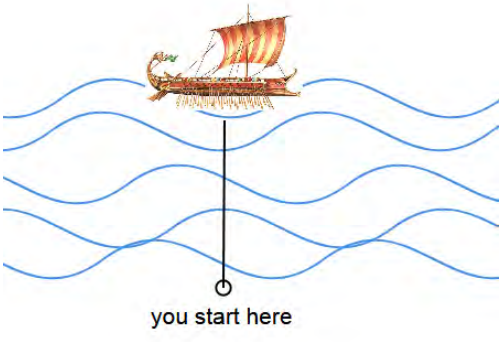
(by Ksenia Shalonova)

**Measuring the distance to a ship**. Thales used geometry for measuring distances. He measured distances to the ships in navigation, distances to the stars and even worked out the height of the pyramid in Egypt.

### Similar triangles

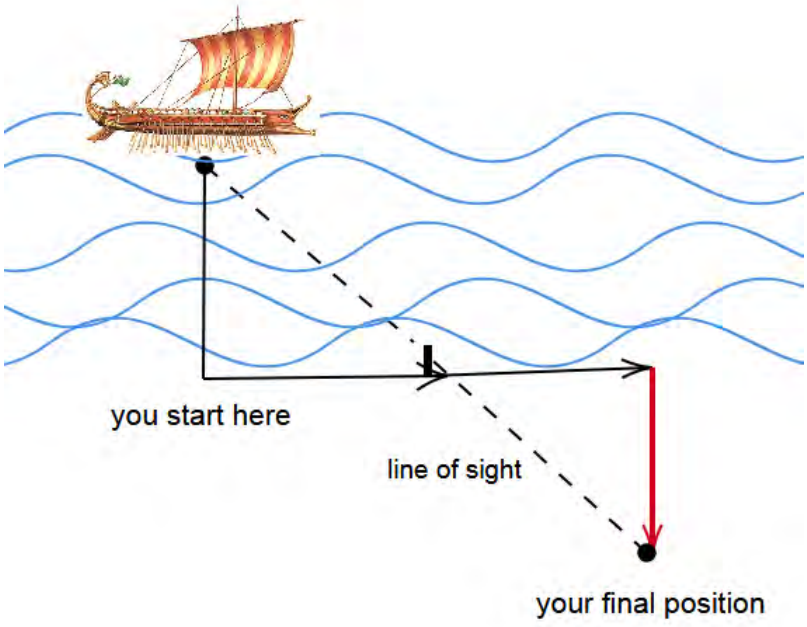
In Ancient Greece they used the properties of the similar triangles to measure distances. In similar triangles, the angles are the same and corresponding sides are proportional. Can you sketch two similar triangles? Can similar triangles be right-angled?

You are standing on the shore and want to calculate distance to the ship. For measuring the distance you are only allowed to use a pole, but you are free to move on the shore.



# Solution

Firstly find the point of the shore which is opposite the ship. Then walk along the shore a particular distance (e.g. 30 steps) where you place a stick. When we have done this we continue walking along a shore and cover an equal distance. Afterwards, we walk (perpendicularly) inland up to the point where we can line up the ship and our stick in our vision. Then (due to the shaping of two equal triangles) our distance from the shore equals the desired distance of the ship from the shore.



# Greek Geometry 3

(by Ksenia Shalonova)

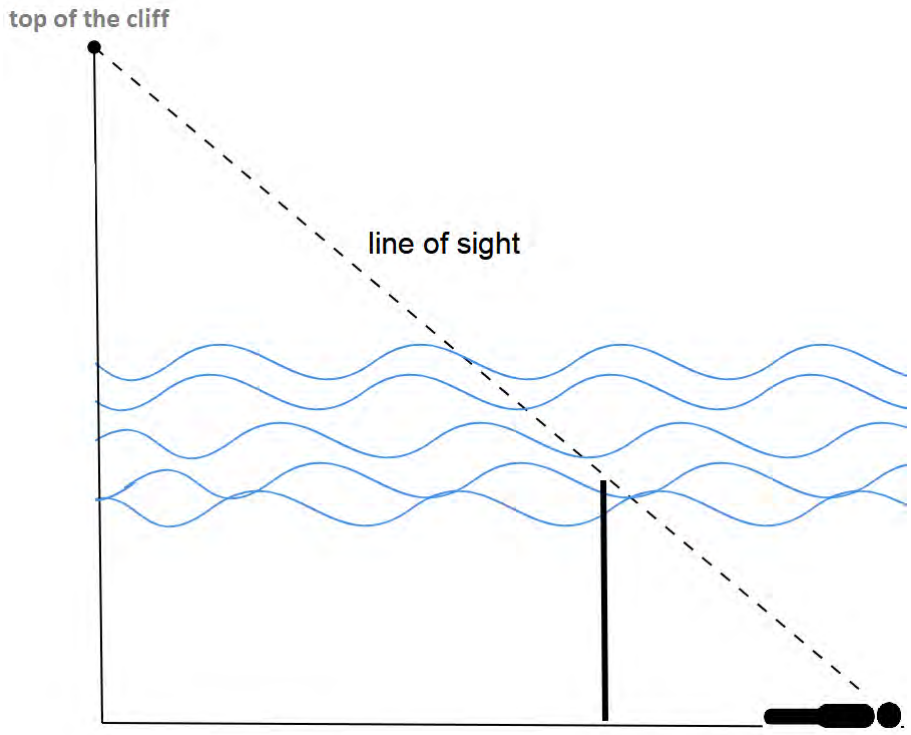
**Measuring heights** There are a number of methods for measuring heights,

for example, you can use the length of the shadow (on a sunny day). You can also use a mirror or a hand-drawn triangle.

In Jules Verne's "The Mysterious Island" Captain Harding wanted to find the height of a cliff and for this he used a tall poll. There is only one disadvantage of using this method - you have to lie down on the ground! Can you figure out how he did it by using properties of similar triangles and the line of sight?

# Solution

We have two right-angled similar triangles with two sides in one triangle whose lengths we know (distance from a person to the pole and pole length) and one known side (the distance from a person to the cliff) in another triangle. By solving the proportion we can find the height of the cliff.



# Greek Geometry 4

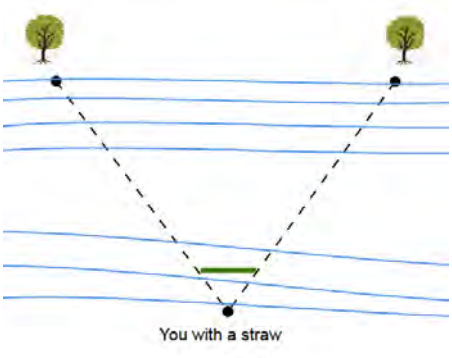
(by Ksenia Shalonova)

## Measuring river width with a straw

**Thales' Theorems**

There are several theorems that are attributed to Thales. For example, the circle is bisected by its diameter or the angle in a semi-circle is right angle. Knowledge of the angles in a circle can help you to solve the next problem.

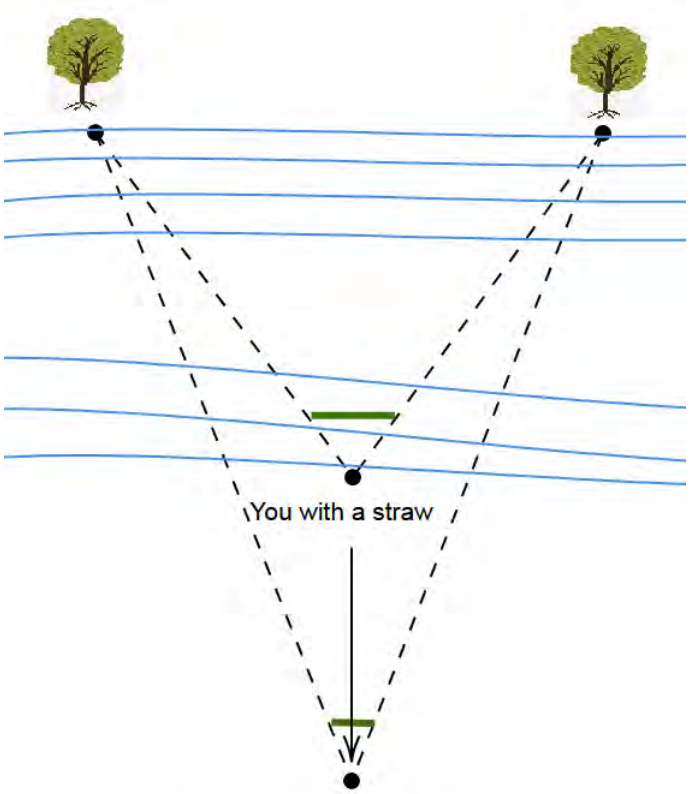
You are standing on a river shore and want to measure an approximate width of a river. You can use a straw (or a small stick). Try to solve the problem first without looking at the hint!



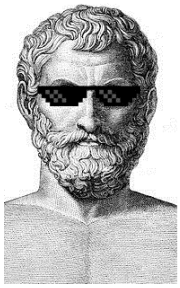

Hint. Notice any two objects on the opposite side of the river (e.g., flowers or trees). Hold a stick horizontally with an outstreched hand where the first object is directly behind the left end of the straw and another object is directly behind the right end of the straw. Reduce the size of the straw - you have to decide by how much. Start moving back until the position of one object is directly behind the left end of the straw and ...

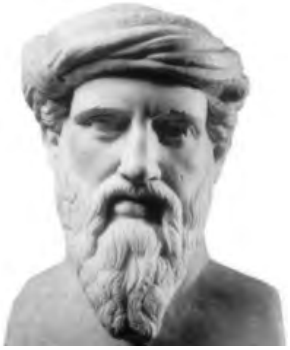
# Solution

Notice any two objects on the opposite side of the river (e.g., flowers or trees). Hold a stick horizontally with an outstreched hand where one object is directly behind the left end of the straw and another object is directly behind the right end of the straw. Now you have to use half of the straw. Start moving back until the position of the first object is directly behind the left end of the reduced straw and the position of the second object is directly behind the right end of the reduced straw. The distance you traveled back is the approximate width of the river.



# Further information





These two guys from Ancient Greece - Thales of Miletus (left) and Pythagoras (right) - made Mathematics a science. They did Maths not only because it was practical, but because Maths was fun.
Pythagoras created his own school - a cult that worshiped numbers. There is still a lot of mystery around it. Thales became famous for shocking everybody by accurately predicting a solar eclipse in Ancient Greece. As both of them enjoyed the process of understanding the world, they called themselves `philosophers.`
The word geometry has its roots in the Greek language and means **earth measuring**. Both Pythagoras and Thales visited Egypt to learn more about Mathematics.

An extension to this topic can be introducing simple mechanisms such as a compass or a basic theodolite (or a protractor) for measuring angles on terrain. This will allow to solve more complicated tasks such as creating topographic maps.

In fact, the basic properties in geometry developed in Ancient Greece are widely used in a large variety of modern engineering applications: GPS positioning systems, space mission design, design of tall skyscrapers, precision manufacture of tiny parts, motion of robotic manipulation, and many more.