Build your Neolithic House

Respective blueprint	Neolithic House of Choirokoitia
Description	Students learn the history of Neolithic Houses and Neolithic settlements in Cyprus. In addition, they use mathematical concepts (area, volume) to calculate their circumference and size.
Learning Objectives	For students to become familiar with: • History of Neolithic Houses / Neolithic Houses in Cyprus • The formula of circumference, area of a circle, and the mathematical symbol π • The formula of a cylinder's volume
Related curricular subject(s)	Mathematics, History
Prerequisites / preparatory actions for teachers	Teachers should make sure that pupils are familiar with the terms of radius, diameter, and weight before introducing the concepts of area and volume. In addition, they could find some photos or videos about Neolithic Houses to show.
Prerequisites / preparatory actions for students	Students should be able to recognize a circle's radius and diameter.

Age of students	12-14 years old
Duration	45 minutes
Level of difficulty	Low to Medium

Step by step description of the tasks

Step 1:

How were Neolithic houses built and which are the most famous in Cyprus?

Figure 1: Neolithic House of Choirokoitia in Cyprus

Source: Visit Cyprus

https://www.visitcyprus.com/index.php/en/discovercyprus/rural/sites-monuments/757-choirokoitia-archaeological-site-neolithic-settlement

The settlement of Choirokitia is thought to be one of the most representative of the Neolithic era in the island of Cyprus. The houses were built with stone at their basis, while the upper part was built with adobe and mud. The roofs were created with branches and straws covered in mud. There was "a fireplace, a kind of grate and a foramen that helped the smoke come out" at the centre of the house.

Most Neolithic houses had an entresol, which was probably used as a storeroom. What is

more, it seems that the houses were built in such a way to be protected by floods as elevated thresholds were built.

What do we know about their shape?

The houses are cyclical, with an external diameter of between 2.30 and 9.20 meters and an internal diameter of between 1.40 and 4.80 meters. Its height was approximately 3 meters, and its thickness was about 2.5 meters.

Step 2: Diameter, radius and circumference of a circle

The teacher asks students to recognize the shape of Choirokoitia's base. A circle is a closed curve formed by a set of points on a plane that are the same distance from its center. Then, they can askss students to calculate its circumference, using the formula:

$$L = 2 * \pi * R$$

where R is the radius of the circle.

At this point, teachers should first implement the respective 3D blueprint and hand it out to students or have children create the model on tinkercad. In both cases, having printed the 3D model in advance would be helpful.

{It is suggested to first implement and 3D print the blueprint before starting with calculations}

Example

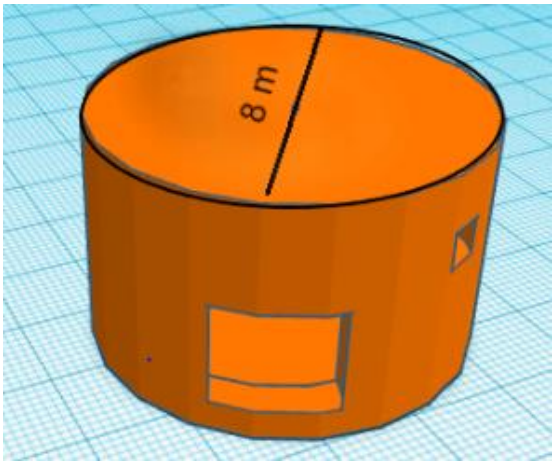


Figure 2: Choirokoitia with a given diameter of 8 m.

Let's assume that Choirokoitia's diameter is 8m. Find its circumference.

Take π as 3.14

Figure 2 shows the circle with a diameter of 8m.

Knowing that the diameter is double the radius: R = 8 / 2 = 4m

To calculate the circumference, we can use the following formula:

$$L = 2 * \pi * R =>$$

$$L = 2 * \pi * 4 = 2 * 3.14 * 4 = 25.12$$

The number 25.12 only has a meaning if we include its unit. Since the radius is in m, the circumference will also be in m. Hence:

$$L = 25.12\ m$$

Step 2: The area of the circle

Now, let's find the circle's area.

The area of a circle is the region enclosed by the circle. The circle's area is equal to pi (π) multiplied by its radius squared.

$$A = \pi * R^2$$

where R is the radius of the circle.

Example

Based on Figure 2, we plug in the value of the radius:

$$A = \pi * R^2 =>$$

$$A = 3.14 * (4)^2 = 3.14 * 16 = 50.24$$

But be careful. The unit of area is the square unit.

Since the radius is in m, the area will be in m^2. Hence:

$$A = 50.24\, m^2$$

Step 3: Cylinder's volume

A cylinder is a solid with two congruent circles joined by a curved surface.

The volume of the cylinder is the area of the base multiplied by its height.

$$V = B * h$$

Where:

- B is the area of the base and
- h is its height

Taking into account that the base is a circle, we can re-write the formula as:

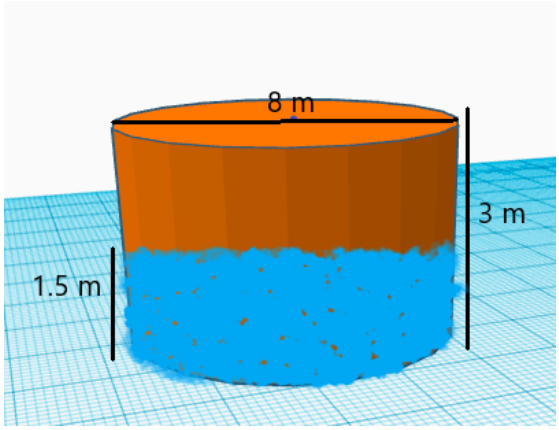
$$V = \pi * R^2 * h$$

Where:

- R is the radius of the circle
- h is the height of the cylinder

Example

Let's assume that our Neolithic House has flooded due to heavy rain, and water has filled the house, as indicated in Figure 3. Calculate the water's volume. The height of the house is given as 3m.



The water fills the house (cylinder) with a height of 3 – 1.5 = 1.5 m

and radius of 4 m.

Hence:

$$V_{water} = B * h_{water} =>$$

$$V_{water} = \pi * R^2 * h_{water} =>$$

$$V_{water} = \pi * (4)^2 * 1.5 = \pi * 16 * 1.5 = 75.36$$

Again, pay attention to the units. The unit of area is the cubic unit.

Since the radius is in m, the volume will be in m^3. Hence:

$$V_{water} = 75.36\, m^3$$

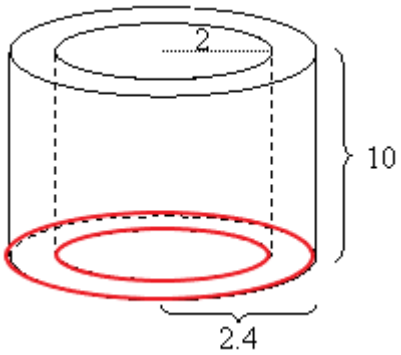
Assessment activities

The teacher could make the following questions to evaluate the activity:

Question 1:

What do you know about the size and materials used in Neolithic Houses?

Question 2:



i. Find the circumference of the interior circle's base.

Solution:

The radius of the interior circle (represented by r) is:

$$r = 2\, m$$

Thus, using the formula

$$L = 2 * \pi * r = 2 * 3.14 * 2 = 12.56\, m$$

ii. Find the area of the exterior circle's base.

Solution:

The radius of the exterior circle (represented by R) is:

$$R = 2.4\, m$$

Thus, using the formula

$$A = \pi * R^2 = 3.14 * (2.4)^2 = 18.0864\, m^2$$

iii. Find the area of the ring between the two circles (area inside the red lines)

Solution:

To find the area of the ring, we have to remove the area of the inner circle from the area of the outer circle.

Using the area's formula for the inner circle (radius r) and outer circle (radius R):

$$A_{ring} = A_{outer,circle} - A_{inner,circle} = \\ = \pi * R^2 - \pi * r^2 = \pi * (R^2 - r^2)$$

	Hence, the area of the ring is: $$A_{ring} = \pi * (R^2 - r^2) =$$ $$= \pi * (2.4^2 - 2^2) =$$ $$= 3.14 * (5.76 - 4) =$$ $$= 3.14 * 1.76 = 5.456\ m^2$$ iv. Find the volume of the two separate cylinders.

References:

1. Community Council of Khirokitia, Available Online: http://khirokitia.org/en/neolithic-settlement/
2. Online Math Learning, Volume of Cylinders, Available Online: https://www.onlinemathlearning.com/volume-of-a-cylinder.html
3. Visit Cyprus, Choirokoitia Archaeological Site (Neolithic Settlement), Available Online: https://www.visitcyprus.com/index.php/en/discovercyprus/rural/sites-monuments/757-choirokoitia-archaeological-site-neolithic-settlement