## Student's worksheet

## TASK

Determine the Circumference of the Earth as Eratosthenes did it in the 3rd century BC.
Use a 1 meter long stick placed vertically on the ground and measure the length of its shadow.

## MEASUREMENT PROCEDURE

1. Place the stick in a Sunny spot, make sure it is vertical (perpendicular ) to the ground.
2. Measure the length of the stick and note down in the table below.
3. Measure the length of the stick's shadow at the local noon.
4. Repeat the measurement 5 times and write your values down in the table.
5. Calculate the mean value for the length of the shadow and write your values down in the table.
6. Calculate length of the third side of the triangle from the picture. Write the value in your table.
7. Write the distance between the two location in your table.
8. Using proportions calculate the Earth's circumference.

## CALCULATIONS



$$
\text { Earth's circumference }(C)=\text { Distance between locations }(L) \times \frac{360^{\circ}}{\text { Central angle } \delta}
$$

$$
\alpha=180^{\circ}-\left(90^{\circ}+\delta\right)
$$

$$
b^{2}=a^{2}+s^{2}
$$



$$
\operatorname{tng} \delta=\frac{\mathrm{S}}{1} \quad \delta^{\circ}
$$

Mean value $=\frac{\text { Sum of measurements }}{\text { Num. of measurments }}$

## EQUIPMENT FOR MEASURING



## HOW TO DO MEASUREMENTS ON A CLOUDY DAY



There is a way to do the measurements even if it is cloudy:

- Mark the position of the base of the vertical stick on the southern edge of a sheet of A0 or A1 paper placed on flat, horizontal, dry ground.
- Then mark the tip of the shadow with a small dot all through the mid morning to mid afternoon, whenever the sun breaks through. The dots will form a curve.
- If you get enough data points and can get a smooth curve then the part of the curve closest to the base of the pole will be the location of the tip of the pole's shadow at true noon.
- This is not correct, but it can give accurate enough readings. At least it will lessen the disappointment that the Sun did not appear.


## ADDITION - DIY (Do it yourself )

This measurement is intended to be performed in a group, but if you are alone even then it can be performed. (if you can, ask someone close to you, to help you briefly while you measure the length of the sun's shadow).

- Go outside to a flat open place where the Sun can be seen. It can be a children's playground, a meadow, wider footpath, a sidewalk in front of your house $\qquad$ whatever
- Take a one-meter stick, $\mathrm{H}=1 \mathrm{~m}$ and all the accessories with you.
- Measure the length of the stick to make sure it is one meter long (it can be different from 1m, but you must know exact length for calculation)
- Place your a stick vertically (perpendicular to the ground) which you can perform with a spirit level or a plumb-bob that be made from a bunch of keys hanging on a rope.
- You will need the help of another person just to hold the stick vertically. But you can do it yourself by leaning the stick (should be vertical) on something solid such as a larger empty box or a low fence or whatever you have imagined. Fasten everything so that it does not fall.
- See in which direction the shadow falls and place a large piece of paper ( AO or more smaller pieces fastened with tape together) on the floor. Press the paper with a stone or something else heavy and do not move it during the measurement.

When the stick is vertical and standing firmly (whether someone is holding it or it is fixed) wait for the exact time of your solar noon.

Start measuring a few minutes earlier and mark the end of sticks shadow, as accurately as possible, with a pencil on paper.

Do it 5 times (at least 3 times). Make sure the paper does not move!
Write down the values of these lengths in the form I send it.
It's time to count.


## 

## Student's worksheet

| Table of measurement |  |  |
| :--- | :--- | :--- |
| Student |  |  |
| Date | Time |  |
| Stick length |  |  |
| Shadow length (1 ${ }^{\text {st }}$ measurement) |  |  |
| Shadow length (2 ${ }^{\text {nd }}$ measurement) |  |  |
| Shadow length (3 ${ }^{\text {rd }}$ measurement) |  |  |
| Shadow length (4 ${ }^{\text {th }}$ measurement) |  |  |
| Shadow length (5 ${ }^{\text {th }}$ measurement) |  |  |
| Mean value for the length of the <br> shadow |  |  |
| Length of triangle's 3 ${ }^{\text {rd }}$ side |  |  |
| Distance between locations |  |  |

## Earth's circumference ( C ) =

