

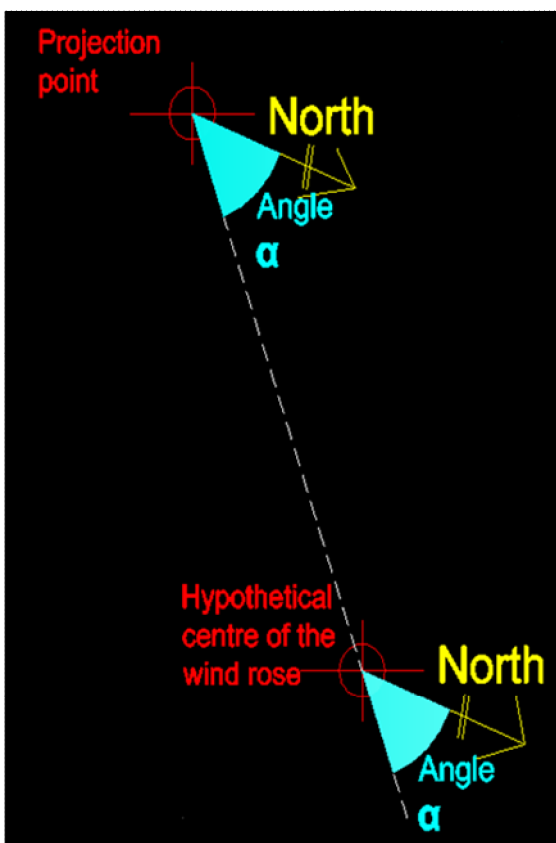
HOW TO DETERMINATE THE GEOPHICAL NORTH

To find the Geographical North, the northern point that coincides with the Earth rotation axis, cannot be used a compass, because this points the Geomagnetic North, which is in the north of Canada, approximately 1650Km from the Geographical North. Therefore, in this project it will be indicated in detail the process to find the Geographical North.

To start, it should be known that every object, at the solar midday, it projects a shadow that points the Geographical North. The solar midday is the exact moment when the Sun is in the zenith of its celestial trajectory; this means that the Sun is shining in the highest point in the sky. What is more, this moment does not match with the horary midday (12:00). The accurate moment of the solar midday is given, among others, by a web page called SunEarthTools. This website generates information and data, like, for example, the daylight hours of a day, the exact hour of the dawn or of the sunset, depending on the geographical place and its time zone. So, considering this information, it comes up our "Determination Method", based on experimentation, to avoid mistakes, and based on the SunEarthTools reliability (which will be tested) checking the incidence angle of the Sun on Earth surface, a very accurate fact that is provided by the website.

This project was done for a contest proposed by IES Sánchez Cantón. The aim of it was to prove and to think about how to orient a wind rose; however, the projection place was too far from the hypothetical wind rose centre, so we had to enunciate another method to translate the obtained direction of the North to another place.

In conclusion, to find the orientation of the Geographical North we will need a sharp and long object to be projected (like a knitting needle), something malleable to nail the sharp object (like plasticine), some string, a protractor, and some adhesive tape.



PROCESS: After studying the IES Sánchez Cantón lobby, we realize that: Leaving an object in repose tied to something (as a pendulum), this will always be perpendicular to the land surface and not to the floor. So:

1. The shadow measurement will be done near a window of the lobby: we will hold the string to something steady (like a table) with the knitting needle tied to it. When the string is not moving, then the object will be perpendicular to the Earth's surface, so we will nail the object to the plasticine block, to prevent its movement.
2. At the solar noon and helped with a synchronized watch with the global hour, we will paste the adhesive tape on the shadow cast, to don't lose the way of it.
3. To move this direction to the centre of the rose, in the entrance of the lobby, we will do the following process: We will connect the point where the knitting needle is touching

the floor with the hypothetical centre of the rose (not put it yet). The angle (α) that it is formed between this line and the shadow of the needle (North direction) will be measured with a protractor, and then moved to the hypothetical centre of the rose with the same amplitude. Finally, the wind rose is properly oriented.

RELIABILITY OF THE WEBSITE “SUNEARTHTOOLS”: With our knowledge of trigonometry, we will be able to find the angle of incidence of the Sun on the Earth’s surface. To do it, we have to know that the height of the object to the floor, the length of the projected shadow and to do the following operation:

$$\alpha = \tan^{-1} \left(\frac{h}{\text{length of the shadow}} \right)$$

- h is the height of the knitting needle (sized in cm like the length of the shadow), and α is the angle of incidence of the Sun over the Earth’s surface (in degrees).

WEB DATA COMPARISON: The mobile app “MeteoGalicia” provides the exact moment of the solar noon too. It also generates data like the exact moment of the dawn and the twilight in the autonomous community of Galicia. To verify the data of both pages, MeteoGalicia and SunEarthTools, when we are measuring the length of the shadow cast, we can write the difference between the measurement of the shadow cast following the SunEarthTools moment and the measurement following the solar noon of MeteoGalicia data.

PRACTICAL COMPARISON FACED TO THE WEB DATA: Keeping into account that at the solar noon the Sun is in the highest level, when we have to point the projected shadow, we can know the direction in a very easy way: The direction that is pointing the North is the one which is pointed by the shortest shadow. So, to avoid theoretical mistakes, the shadow lengths can be taken each one with a difference of five minutes. When the measurements had been made after and before the solar noon, we will look for the shortest segment with its appropriate time slot.