a WOW Lab BLUEPRINT

The Human Sundial

Prep Instructions

Part I - Sizing the Sundial

The sundial requires specific proportions in order to accurately tell the time. These proportions can be calculated by hand or using an Excel spreadsheet.

Step 1

In order to construct an accurate sundial, the latitude of the location is needed. There are many ways to find it, such as using a quadrant, an ancient navigational tool. However, an easier way is to simply research it on the Internet. Record the latitude in the table provided below.

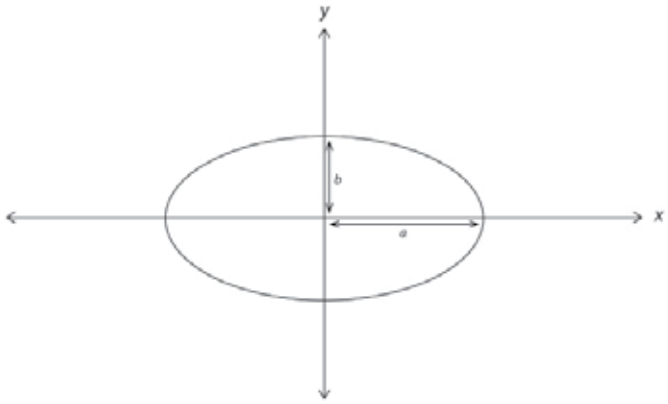

Figure 1

Step 2

Select the height of the gnomon (perhaps the height of one of the students in the class) and record it in the table.

Step 3

Using the equations provided below, calculate the length of the minor (North-South) and major (East-West) axes of the ellipse (**Figure 1**). The students may be able to assist in these calculations. For both methods of sundial construction, the axes will need to be a little longer than these calculated lengths. Lengths of about 2 m for the minor axis and 3 m for the major axis will be adequate for most gnomons.

Variable	Formula	Value	Units
height of gnomon (h)	-		cm
latitude (φ)	-		o
North-South or minor axis (2b)	h x tan (φ)		cm
East-West or major axis (2a)	2b ÷ sin (φ)		cm

Part II - Scale of Dates

The angle at which the sun's rays hit the plane of the equator is called the *angle of declination*, θ. Since the earth rotates around the sun in an elliptical orbit, this angle is constantly changing. The sundial needs to be adjusted depending on the time of year.

The table below shows the angle of declination of the sun on the first of each month. These angles are used to give us the position of the gnomon at various times during the year. For each angle, calculate S (the distance from the origin along the y axis) using **equation 1**.

It is interesting to note that while S appears to be dependant on the latitude of the location, it is actually only changed by the angle of declination of the sun. Therefore, the values of S for a sundial in Montreal will be exactly the same as the values of S in London, Sydney, and Tokyo.

Equation 1: $S = a \times \tan(\theta) \times \cos(\varphi)$

Date	Angle of Declination, θ°	S (= a x tan(θ) x cos(φ))
January 1	-23.13	
February 1	-17.30	
March 1	-8.00	
April 1	4.25	
May 1	15.00	
June 1	22.00	
July 1	23.00	
August 1	18.00	
September 1	8.50	
October 1	-2.90	
November 1	-14.00	
December 1	-23.40	

Some points will be negative, indicating that the gnomon should stand south of the x-axis. The positive points indicate that the gnomon should stand north of the x-axis. To use these points, refer to the *Activity Instructions*.

Part III - Finding True North

The sundial needs to be oriented towards true north (the direction of the North Pole). However, a compass will always point towards magnetic north. The angle between true north and magnetic north is dependant on location and the date. For suggestions of some online calculators for finding true north, see *Resources*.