Lab 1: Measuring the diameter of the Sun

For this lab I just want you to:

1. Fill the table below with your raw data. The data you got the day you took the measurements.

Trial	Diameter of Sunball	Distance to pinhole
1		
2		
3		
4		
5		
Average		

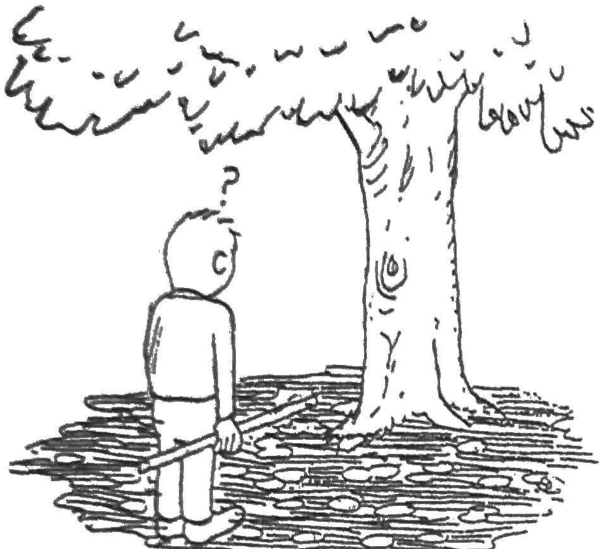
2. Answer the questions on the attached Conceptual Physics Practice Page. Use the average of your measurements for question 4.

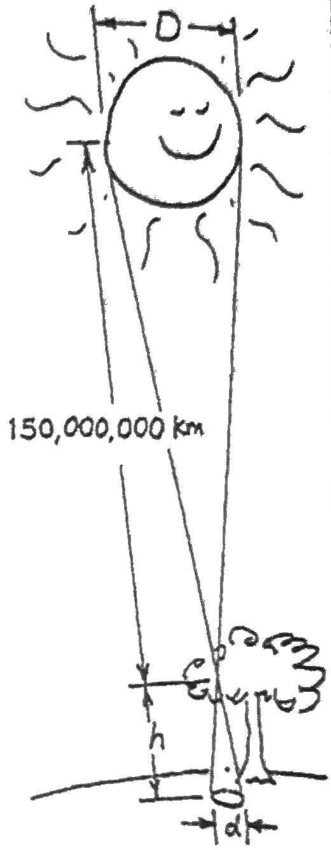
3. Compare your result with the accepted value of 1.4×10^6 km.

4. Discuss the sources of error and how could you have gotten a more precise measurement.

Chapter 1 About Science
Pinhole Formation

Look carefully at the round spots of light on the shady ground beneath trees. These are *sunballs*, and are actually images of the Sun. They are cast by openings between leaves in the trees that act as pinholes. Large sunballs, several centimeters in diameter or so, are cast by openings that are relatively high above the ground, while small ones are produced by closer "pinholes." The interesting point is that the ratio of the diameter of the sunball to its distance from the pinhole is the same as the ratio of the Sun's diameter to its distance from the pinhole. We know the Sun is approximately 150,000,000 km from the pinhole, so careful measurement of this ratio tells us the diameter of the Sun. That's what this page is about. Instead of finding sunballs under the shade of trees, make your own easier-to-measure sunballs.





1. Poke a small hole in a piece of cardboard (like with a sharp pencil). Hold the cardboard in the sunlight and note the circular image that is cast. This is an image of the Sun. Note that its size does not depend on the size of the hole in the cardboard, but only on its distance. The image will be a circle when cast on a surface that is perpendicular to the rays—otherwise it's "stretched out" as an ellipse.

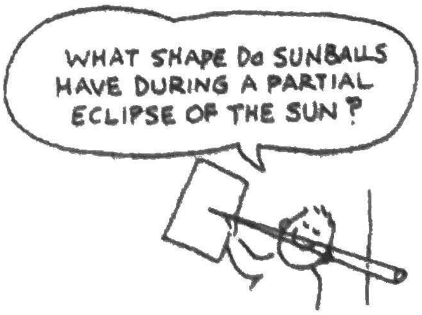
2. Try holes of different shapes—say a square hole, or a triangular hole.

   a. What is the shape of the image when its distance from the cardboard is large compared to the size of the hole?

   ____

   b. Does the shape of the "pinhole" make a difference?

   ____



3. If you were doing this when the Sun is partially eclipsed, what image shape would you expect to see?

   ____

4. Measure the diameter of a small coin. Then place the coin on a viewing area that is perpendicular to the Sun's rays. Position the cardboard with its small hole so the image exactly covers the coin. Carefully measure the distance between the coin and the small hole in the cardboard. Complete the following:

$$\frac{\text{Diameter of sunball}}{\text{Distance of pinhole}} = \_\_\_\_$$

With this ratio, estimate the diameter of the Sun. Show your work on a separate piece of paper.

Hewitt Drew it!

Homework 1: Conversion of units

1. GN-z11 is the most distant galaxy we have observed, its distance from us is 9.8 Giga **parsecs** (Giga = 10^9). The **parsec** (symbol: **pc**) is a unit of length used to measure large distances to astronomical objects outside the Solar System.

If 1 **pc** = 3.26 light years (**ly**) and 1 **ly** = 9.45×10^{15} **m**.

a) How far is GN-z11 in **ly**?

b) How far is GN-z11 in **Km**?

2. The size of protons have been measured to be 0.84 **fm**. A **femtometer** (symbol: **fm**) is 10^{-15} meters. Compare the distance to GN-z11 (above) to the size of a proton (give an order of magnitude difference as an answer).

3. You use about 3×10^8 **Kg(m/s)²** of energy every day. How much is that in **kWh** (**kilowatt hour**)? (Hint: look at the lecture slides for help)