

Experiment #8: Estimating the Earth's Density



**PART 3 IN A SERIES OF
“WHERE DO THOSE NUMBERS IN
OUR BOOKS COME FROM?”**

Flashback!



Who Can Remember What Density Is?

$$\textit{density} = \frac{\textit{mass}}{\textit{volume}}$$

$$= \frac{\textit{amount of stuff}}{\textit{space that stuff takes up}}$$

Estimating the Earth's Density



- Why, you ask? Well, why NOT?
- We need two quantities to get Earth's density: Earth's Mass and Earth's volume
- How do YOU think we can determine these quantities?

WE ARE DETERMINING THE DENSITY OF THE EARTH WITH WATER BALLOONS AND A STICK!

Determining Earth's Radius



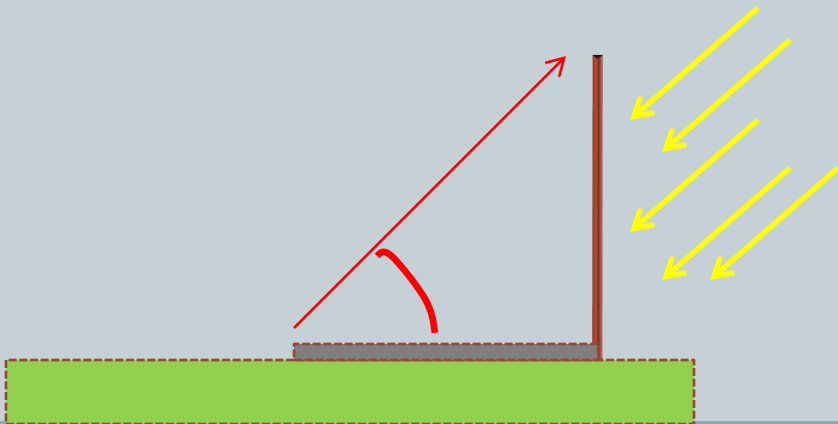
- We are going to use a method first implemented by Eratosthenes over two thousand years ago!
- What are some of the main points of his method? He measured the height of the Sun in the sky in two different locations, and used the difference in heights and the distance between the locations (plus a little trig) to get an estimate of the circumference
- We are going to do the same!

Determining Radius, Step 1: Measuring Angles



1. Measure length of post
2. Stick post in ground; measure length of shadow
3. Calculate angular height of Sun in LC using

$$angle = \arctan\left(\frac{\textit{shadow length}}{\textit{post length}}\right)$$



Determining Radius, Step 2: Computation

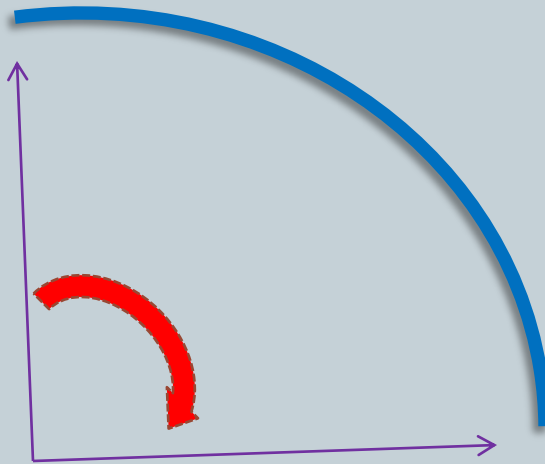


1. Write down Boulder angle
2. Plug-and-Chug!
Get circumference first, then radius

What are we doing?



- By measuring difference in angular heights, we determine curvature of Earth's surface
- We assign to this curvature a physical distance and multiply by 360 to get circumference



Determining the Earth's Mass



Newton's Law of Gravitation is your Friend!

$$g = \frac{GM_E}{R_E^2} \Rightarrow M_E = \frac{gR_E^2}{G}$$

It gives you an easy way to find M_E
Just need to find g , acceleration due to gravity

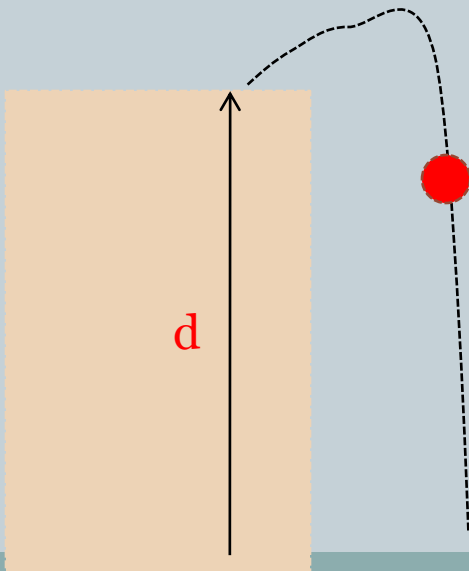
Determining the Earth's Mass...

With Water Balloons...

Thanks to Newton's Law of Gravitation, we have this handy-dandy formula:

$$d = \frac{1}{2} gt^2 \Rightarrow g = \frac{2d}{t^2}$$

1. Time how long ball takes to drop
2. Calculate g using your time and d
3. Plug into equation for M_E



FINALLY, Calculate Density of Earth!



- All formulae are in your lab manual
- Make sure to answer all questions
- Pat yourself on the back, you just calculated the density of the Earth with water balloons and a stick!