

Math 181
Day 16 Notes

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What are some large numbers?

1. The grains of sand needed to fill up the universe.
2. Number of electrons/atoms in the Earth
3. The number of atoms in a standard quantity of matter. 6.22×10^{22}
4. Tree(3) where the Tree function is the maximum number of Trees you can create with a specific coloring.
5. The Monster Group.
6. Super permutations
7. Graham's Number

Archimedes on Grains of Sand

Split into sections

1. Cover Letter And Introduction to the Problem
2. Geometry for Estimating the Size of the Universe
3. Numerical Estimates
4. Describes System of Numerals From Earlier Work

Numerical Estimates

Archimedes takes the Universe to be a sphere centered on the Earth, which has an outer edge passing through the center of the Sun.

Archimedes uses four numerical estimates which were famous enough at the time that the King would be somewhat familiar with them.

1. The perimeter of the Earth is about 3,000,000 Stadia.

1 Stadia \approx 150 meters

2. The Diameter of the Earth is greater than that of the moon, and the Sun is greater than the Earth
3. The diameter of the sun is around 30 times the diameter of the Moon.
4. The diameter of the Sun is greater than the side of a regular 1000-gon inscribed in a great circle inscribed on the Universe sphere.

What do we need?

1. We need the distance from the Earth to the Sun, to calculate the volume of the Universe.

Next time the calculation, today the answer is 1000 times the diameter of the Earth. Very convenient so that was nice for Archimedes.

Archimedes refrains from exceeding 1000 so that the King can continue to follow along with Standard Greek Numerals.

The next estimate is the size of a grain of sand. Archimedes takes the approach of assuming the number of grains of sand in a sphere with a diameter of the 1/40th the smallest unit the Greeks had, contained 1000 grains of sand.

A fingerbreadth(daktylos) is around 19.3mm.

Using the formula for the volume of a sphere, we find 1000 grains of sand per $\frac{4}{3 \cdot 80^3}$ cubic Daktylos.

We then can use the size of a grain of sand to convert the volume of the Universe to sand.