

# TEACHER GUIDE for Water Calculations

*Q. Could the water in Earth's oceans have originated from rocks?*

**We are trying to decide if there is enough water in space rocks to account for the presence of Earth's surface water, the hydrosphere (oceans and freshwater).**

In essence, we need to make a comparison between the water composition of space rocks and the water composition of the Earth.

According to our pre-lab reading, the (enstatite) chondrites that formed the Earth have a water content of 2,000 to 12,000 ppm. In percentages, this is 0.2 to 1.2%. (Make certain you know how to convert from ppm to percentages before you work through the math with your students. Straightforward on paper but always a bit trickier in front of the class!)

Earth's hydrosphere represents about 0.23% of its total mass, so the water found in these inner solar system chondrites easily accounts for the totality of the water in Earth's oceans. Any excess water may be stored in the mantle, the crust, or may have been lost to space over time. The class doesn't need a perfect account, we just need to recognize that there is enough water in space rocks. Essentially, even though water occurs at low concentrations in space rocks, the water content of Earth itself is in fact really low. The key insight is that all of the water in all of the world's oceans, lakes and streams still only represents a tiny fraction of the mass of the planet.

Some data that will be useful in your calculation with the class:

*From the Wikipedia article, "Oceans" (<https://en.wikipedia.org/wiki/Ocean>):*

*"The total mass of the hydrosphere is about 1.4 quintillion tonnes ( $1.4 \times 10^{18}$  long tons or  $1.5 \times 10^{18}$  short tons or  $1.4 \times 10^{21}$  kg), which is about 0.023% of Earth's total mass ( $5.972 \times 10^{24}$  kg). Less than 3% is freshwater; the rest is saltwater, almost all of which is in the ocean."*

In knowing the percentage of Earth that is surface water (= 0.023%), we have a minimum bar to reach. So, we're hoping that space rocks contain (on average) at least 0.023% water if they are to explain the origin of water on the planet. This is equivalent to 2300 ppm. The prelab gives us a healthy range, with the majority of space rocks of the type that formed Earth falling at or above this 2300 ppm threshold.