# Lesson 1: Alien Oceans

Adapted from Jet Propulsion Laboratory: <https://www.jpl.nasa.gov/edu/teach/activity/discovering-alien-oceans-density>

## Objectives:

Students will learn how, understanding properties of density, they can propose a model for the interior structure of Europa.

Students will learn about Jupiter’s icy moon, Europa, that has a liquid-water ocean under the frozen surface. Scientists cannot see the ocean underneath, but through the use of data can predict that it still exists.

## NGSS:

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine whether a chemical reaction has occurred.

MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

## Essential Questions:

* How do scientists use models to predict structures in space?
* How can data be used to propose models of structures in space?

## Materials:

* Clear plastic or glass jars
* Scales (talking scales are preferable for students with visual impairments)
* Water
* Ice cubes
* Variety of materials more dense than water, such as rice grains, sand, corn kernels, etc.
* Measuring cups for measuring volume
* Rulers (it may be helpful to have large print and braille rulers available)

## Directions:

1. Discuss a bit of background about Europa.
2. NASA has a video available at: <https://youtu.be/OzGNy-PWAH0>.

*Note*. There are many visuals in this video. Some additional descriptions are provided, but the teacher may need to provide additional voiceover, depending on the needs of the student.

1. You may also want to have students conduct their own research on the Internet to learn more information. You can challenge them to find out information about how scientists used data from the Galileo spacecraft, the Deep Space Network, and the planned Europa Clipper mission to learn more about Europa’s inertia, trajectory, and magnetic field.
2. Students can be divided into groups to find the information or assigned one of the data-gathering mechanisms used by NASA.
3. Students should be encouraged to share their findings with the class so that all students can learn from one another.
4. Now, inform students that they will be creating a model to discuss density and mass distributions to determine composition of celestial objects.
5. Put groups of students together. Provide each group with a jar, ruler, ice, water, and two granular materials (note that not all student groups should have the same granular material combinations). Put a tactile line on a jar to indicate the height of the water that should not be filled past to prevent spilling.
6. Discuss how density is measured. [Mass divided by volume.]
7. Discuss as a class how they could compare density levels if their granular materials are different. [Answers vary.]
8. Have students fill their jar with at least 1 cm of granular material. Students may want to use their rulers to place a tactile marker on the outside of their jar to indicate the height of where the material needs to be. Then, have students put their middle finger of one hand inside the jar to fill the level with their materials while the ring and pinky finger are on the outside of the jar. Have the students feel the tactile marker with their ring finger and see whether it matches the height of their middle finger of material.
9. Ask students to find the mass and density of their jar.
10. Now, add at least 1 cm of water to the jar, repeating the method described above. Find the density of the jar with the water.
11. Last, add a few ice cubes and record mass and density measurements one last time.
12. Tell students to conduct the experiment again, using a new jar and new material provided.
13. Ask students to write a prediction for each layer using the new material.
14. Follow Steps 6–9 with the new material.
15. Ask students to describe how the mass, volume, and density changed with each layer and with each new material. Was it close to what was predicted?
16. What is different about the two jars?
17. How did each group’s measurements vary? [Discuss as a whole class.]
18. How does the data found in the experiment relate to the structure of Europa?
19. How does measuring density and mass help in determining the composition of planets? [Understanding the volumes of liquids vs. the materials on planets.]