Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Space Ice: Naughty or Nice for Life?

Lesson plan for grades 3-5
Length of lesson: 90 minutes
Adapted by: Louisa Torrance, Environmental Science Institute, 07/06/12

SOURCES AND RESOURCES:

- Britney Schmidt, on chaos terrain
  http://www.utexas.edu/know/2011/11/16/europa_great_lake/
- Mr. Bergis temperature experiment
  http://www.youtube.com/watch?v=P7-hf8Kd2_U&feature=related
- **Hydrothermal Vent Life Pictures**
  http://www.deepseaphotography.com/vent_animals.html

POTENTIAL CONCEPTS TEKS ADDRESSED THROUGH THIS LESSON:

§112.15. Science, Grade 4: 5(b)
§112.14. Science, Grade 3: 5(a)

PERFORMANCE OBJECTIVES (in order of increasing difficulty to permit tailoring to various age groups):

Students will be able to:

- Understand processes supporting life on Earth can and are happening in space
- Observe the movement of warm water in relation to colder water, and ice in relation to liquid water
- Predict how warm water in contact with ice causes melting on Europa

MATERIALS (per group of four):

- Clear (transparent) plastic tub
- Ice cold water
- Ice sheet
- Small, glass water sample bottles
- Food coloring
- Thermometers
- Soda Can PowerPoint Slides

CONCEPTS:

Water Density – Water has different physical properties when it is at different temperatures. Heat from Europa's internal environment can cause warm water to rise and melt it's icy shell.

Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Properties of water – Melting, heating, and freezing of water as a function of temperature create different environments on Earth, as well as in space. Water is essential for life on Earth, so finding water in space presents exciting evidence for the possibility of extraterrestrial life.

BACKGROUND:

Why do we care about studying Europa? Well for one, it has ice! Ice is the solid, or frozen form of liquid water, which is abundant (and essential) on Earth. After looking at Europa's surface, scientists found that particular regions, called chaos terrain, appear to have been formed by the melting and refreezing of ice.

This leads us to believe there may be an ocean underneath the ice that is being heated by the core of Europa. Scientists hypothesize that on this planet, warmed water near the core rises to the icy shell and subsequently melts it. The experiment which follows shows students this rising movement, introduces the concept of water density, and how melting ice forms liquid water. Because evidence for this process is observed on Europa, students can infer how processes on Earth may also appear in space, and how this can be used to form hypotheses (or scientific predictions) of whether a moon or planet may have life.

PREPARATION:

Have 1-inch sheets of ice frozen to the size of the plastic bins. Prepare small glass bottles with water and red dye and heat on a hot plate, in a warm water bath, or in a microwave during the **Engage** section. Assign roles to each student to ease preparation and clean-up.

ENGAGE:

Have one student read this article passage aloud to the class:

August 13, 1996

"These fantastic new images of an icy moon of Jupiter are reminiscent of the ice-covered Arctic Ocean on our planet. The lack of craters, the cracks and signs of movement, all indicate that this might be young ice on a dynamic surface. It raises the possibility of a liquid ocean on Europa, the only other place in our solar system where we suspect such an ocean might exist."

-Daniel S. Goldin, Administrator of NASA (1992 – 2001)

Next, students can draw or write a few sentences describing what they think the environment of our moon is like. Then ask if they think other planets have moons too. Would those moons be similar or different than ours?

Ask students how this environment on one of Jupiter's moons is different from our moon, and from Earth. What is special about this moon? Why might astronomers be interested in it?

Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Guide students to think about the ocean.

Teacher Asks: What is an ocean? Where is the ocean on Europa? Could life exist underneath ice?

EXPLORE:

1. Assign jobs for each student by breaking the class up into groups comprised of three team members – scientist (inserts warm water tube/takes water temperature), recorder (observation/data collection), materials (gets materials for group), and maintenance (cleans up materials).
2. Prepare plastic bins for each lab group. Fill each bin half full with water.
3. Have the scientist take the temperature of the water in the bin and record.
4. Distribute ice sheets for placement in the bins. Have students write down where the ice is. As a brief illustration to compare the density of frozen water to liquid water, students may push ice down and watch it rise to the surface.
5. Hand a water tube with dye to each group.
6. Have the scientist then take the temperature of the water tube and record.
7. Carefully lifting the ice sheet, turn the water tube on its side. Be sure students watch the red, colored water move towards the surface and hit the ice! Refer to Mr. Bergis' temperature experiment on YouTube in **Sources and Resources** section.
8. Clean up materials.

EXPLAIN:

Teacher Asks:

- Where did the warm water go? Instructors should guide questions so that students reflect that the warm water moved up until it hit the ice. What do you think would happen to the ice sheet if enough warm water were flowing directly underneath it? It may melt!
- What could possibly make warm water on Europa? Think about our own planet – what is the environment like inside the Earth? Heat coming from its internal environment.
- Discuss the cycle of melting, freezing, and warming water.

ELABORATE:

1. We saw many interesting properties of water today, such as floating ice, and rising warm water! This has to do with a property called *density.* If something floats, we say it is LESS dense than what it is floating on. Draw a sketch of what happened with the tubs on the board and label the ice, warm water, and tub water.

   Ask: Which is denser:
   A. ICE or LIQUID WATER?
   B. WARM WATER or COLD WATER?
   C. ICE or COLD WATER?

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Ice is very unique. It looks different than liquid water. It also floats on water. Why is this?

Density = mass/volume
Mass is an objects weight. Volume is how much space and object takes up.

Ask students if they have ever placed a water bottle in the freezer. After a while, the bottle exploded, because the water turned to ice and expanded! This means it has a LARGER volume, or took up more space. (Show Slide #1 of Soda Can).

Let's practice. If water has a mass of 1.0 g, and its volume is 1.0 cm3, what is its density?
If ice has a mass of 1.0 g and its volume is 1.5 cm3, what is its density?

If we compare our answers, we see that water has a density of 1.0 g/cm3, and ice has a density of .66 g/cm3. Which one is less? Remember if the density of something is LESS than another, it will float on top.

Teachers: It is very important to spend the necessary time ensuring students answer these comparisons correctly. Students may not initially grasp the fact that cold water is denser than warm water, yet frozen water (ice) is less dense than cold water OR warm water. Explain to them that ice expands when it freezes, and therefore occupies a greater volume of space than liquid water, making it less dense.

2. Liquid water is an essential part of life on Earth. *Ask:* What part of our experiment showed us how solid water (ice) can be turned into liquid water? The goal is to have students reflect that the rising, warm water hitting the ice sheet melts it, creating liquid water!

EVALUATE:
Have students create travel brochures for Europa. The travel brochures must include the following content that teachers can evaluate:

- where Europa is located and what it is
- explain to tourists what is happening underneath the ice
- predict where space tourists *might* see life on Europa (here, students should reflect the fact that we are not certain there is life there, but we can make a hypothesis about it
- what kind of life might exist on Europa, and what to pack for the different temperatures. It may be helpful to provide pictures of hydrothermal vents on earth such as the ones found at the hyperlink listed in Sources and Resources:

Soda can in the freezer…WHOOPS!

BEFORE

AFTER

The soda turned into ice and INCREASED its volume!