Description: Learners test various samples of water for clarity.

Background: Measuring water clarity is an important part of environmental science. Often lakes or streams contain pollutants or sediments that make the water cloudy. This often has negative implications for the organisms that live in the water. In this activity, learners will test samples of water for clarity by using a small Secchi (sea-key) disk. Water clarity may be affected by three different factors: 1) algae, 2) sediment, and 3) water color. A photometer is used for a more precise measurement of light in aquatic environments.

The Secchi disk is typically an eight-inch diameter circle. It is a flat metal object that has alternating black and white quadrants. A calibrated line is attached to the Secchi disk in order to measure the maximum depth at which it is visible. The Secchi disk is used to estimate the depth that light can penetrate into water. It is lowered into a body of water by unwinding the cord to which it is attached until the observer loses sight of it. The disk is then raised until it is visible again. The depth of the water where the disk vanishes and reappears is the Secchi disk reading. A more accurate measurement is obtained when this process is done several times and the mean is calculated.

Determining the clarity or level of contaminants in water is a critical matter for NASA's Genesis mission. In order to collect pure samples of solar wind, Genesis scientists had to first ensure that the collection materials launched into space were contamination-free. Each piece of the collection instruments had to be cleaned in hot, ultra-pure water in a sterilized, contamination-controlled room at the NASA Johnson Space Center known as the "Cleanroom." Then, to verify that the collection materials met the strict criteria to be considered truly clean, Genesis scientists, outfitted in special cleanroom suits, frequently tested the rinse water using an instrument called a liquid particle counter. Like the Secchi disk, the liquid particle counter can be used to determine the clarity of water. The difference, however, is that the liquid particle counter can be used to identify *microscopic* contaminants that can't be seen with the human eye, while the Secchi disk can measure the clarity of water on a *macroscopic* level that is visible to the human eye. Learners can take an interactive, virtual field trip to the Genesis Cleanroom by visiting: http://www.genesismission.org/educate/Field_Trip/genesis/cd_index.html

National Science Standards[1]
3-5 Nature of Science
Understands the nature of scientific inquiry
Plans and conducts simple investigations

3-5 Life Sciences

Understands relationships among organisms and their physical environment

Knows that all organisms (including humans) cause changes in their environment, and these changes can be beneficial or detrimental

3-5 Earth and Space Sciences

Understands Earth's composition and structure

Knows how features on the Earth's surface are constantly changed by a combination of slow and rapid processes

[1]Kendall, J.S. & Marzano, R.J. (2000). *Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education.* (3rd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Materials

For the leader demonstration, discussion and four stations:

- Four 1000 mL beakers, larger graduated cylinders or similar tubes. (Each will contain different concentrations of colored salt water — see Procedure 1 below).
- One measuring cup or cylinder (to measure salt content in mL for solutions)
- Salt
- Food coloring
- Water
- Index cards (as labels for each cylinder)

Leader Tip

Starch solutions of different dilutions can be used instead of water, salt, and food coloring.

For each group of three to four participants:

- Plastic lid (like the lid from a yogurt or cottage cheese container)
- Black permanent marker to color Secchi disk
- Four markers — various colors (to use in measuring each of the four water samples)
- Compass
- Washers or weights that have a hole
- String (about 1.5 meters per group)
- Paperclip
- Ruler
- Write-On Sheet, "Clear Water"
- Interactive Field Trip, "Liquid Particle Counter." Optional activity available at: http://www.genesismission.org/educate/Field_Trip/genesis/cd_index.html#

Advanced Preparation:
Before class, make copies of the Write-On Sheets. You will also need to prepare three different liquids for the opening discussion. Fill four containers with 1000 mL of water and five drops of green food coloring. To the first container add nothing and label it "A". To the second container, add 15 mL of salt and label it "B". To the third container, add 60 mL of salt and label it "C". To the fourth container, add 120 mL of salt and label it "D". Use the instructions on the Write-On Sheet to construct a sample Secchi disk that can be used as an example for participants. Practice using the Secchi disk with your water samples.

Procedure:

1. In the discussion that precedes the activity, show participants the four containers of liquid and ask them to describe the contents of the container and then to note any differences in the contents. (They may suggest that the containers contain colored liquids. They may note the clarity of the liquids differ from container "A," to container "B," to container "C," to container "D.") Ask learners to provide reasons that may cause the liquids to appear differently. Ask them for any evidence they have to make the inferences. Participants may write their observations on their Write-On Sheets.


Pilot test educators measure the clarity of four samples of water.

2. Explain that a Secchi disk can be used to measure the water clarity of a sample of water. For more information on the history and science of limnology *(the study of the transparency of water)* go to: http://genesismission.jpl.nasa.gov/educate/scimodule/CleanRoom/pdfs/MacroToMicroST.pdf
   You may want to provide this limnology student sheet to participants who are interested in learning more about the uses of a Secchi disk.

3. Tell participants that they will construct a Secchi disk to measure the water clarity of the four samples and then, possibly, some samples from a local source. Demonstrate the use of the Secchi disk using the example that you made.

Leader Tip
The following are results obtained by the authors given here to provide guidelines for teachers to show some expected results.
Sample Secchi Averages:
- A. N/A
- B. 29 cm
- C. 20 cm
- D. 14 cm

4. Provide the materials for constructing the Secchi disk to each group of three to four participants. Assist participants in constructing the Secchi disk as needed. The Write-On Sheet has directions that participants can use to construct a Secchi Disk.

5. Set up four stations, each with a different water sample labeled A, B, C, or D.

6. Once a group has constructed their Secchi disk, they may go to one of the four stations to test the clarity of the water sample. Tell participants that they may want to test each sample more than once to make sure their measurements are accurate. Instruct participants to write their data in the appropriate place on their Write-On Sheet.

7. Each group should rotate around until they have tested the water samples at each of the four stations. Encourage groups to be sure that each individual has an opportunity to use the Secchi disk to test a water sample's clarity.

8. (Optional) Provide water samples from local bodies of water (use samples that include a variety of clarity levels) for the participants to measure the water clarity.

9. Discuss the questions that are found on the Write-On Sheet. For question 1, participants might suggest that using a Secchi disk provides numbers that are sometimes easier to use for comparisons than descriptions. For question 2, participants might suggest that this procedure would be helpful to monitor the conditions of a body of water over time. For question 3, participants might suggest that humans or other organisms could cause pollution, or that the cloudiness could be due to increased sediment (dirt) getting into the water. Explain to participants that for this activity, water clarity was changed by adding different amounts of salt.

10. (Optional) Participants can further explore available technology in the Genesis Cleanroom Interactive Field Trip available at: http://www.genesismission.org/educate/Field_Trip/genesis/cd_index.html

This interactive will show participants how contamination can be measured and controlled to minimize any risks to NASA's Genesis mission. The Genesis spacecraft traveled one million miles toward the Sun to collect pure samples of solar wind particles that may help scientists to understand the earliest building blocks of our Solar System.

Extension Activity

You may want to have your participants construct a Secchi disk for measuring the water clarity of a local lake. Below are instructions for them to construct and use their own Secchi disk. Take a firm metal disk (an aluminum pie plate would work) about 20.32 cm in diameter and paint it with several coats of white enamel. Divide the face of the disk into four quadrants and paint the alternate sections black.

Attach the disk at the center to a rope or chain. Make sure that the disk is centered and will not tip as it is placed into the water. Lower the disk into the water and mark the depth at which the disk disappears. Sink the disk several more centimeters then raise it, mark the depth at which it reappears. Pull up the disk and measure the two distances. Average the two observations to obtain a single reading. You may be interested in having your students enter the Great North American Secchi Dip In. Go to: http://dipin.kent.edu/ to learn more about this event.

This activity was adapted for Community Quest from an activity in the Genesis education module *Dynamic Design: The Cleanroom* found at:
http://www.genesismission.org/educate/scimodule/CleanRoom.html

Resources for Extension and Enrichment Activities

http://www.fortworthgov.org/DEM/kidsnet.htm
The Environmental Management Department of the City of Fort Worth, Texas offers some engaging interactive sites and lessons that deal with water and air pollution.

http://www.genesismission.org/educate/Field_Trip/genesis/cd_index.html
Take a virtual field trip to the Genesis Cleanroom where visitors have the opportunity to see the technology and play interactive games that simulate the experiences of NASA scientists and engineers.