LESSON PLAN

Space Stations and Water Purification

1. GENERAL

This class will familiarize the Mission Team with recycling that needs to be done on the International Space Station in order to live in space. This class is presented to expand the terrestrial and space knowledge of all Galaxy Explorers in order to enhance their competence and confidence of all aspects of space.

2. LEARNING OBJECTIVES

SUBJECT AREA: Engineering

TASK: Team members will learn about recycling and water purification, and they will construct a filter to simulate the system used on the International Space Station.

3. PRESENTATION GUIDE

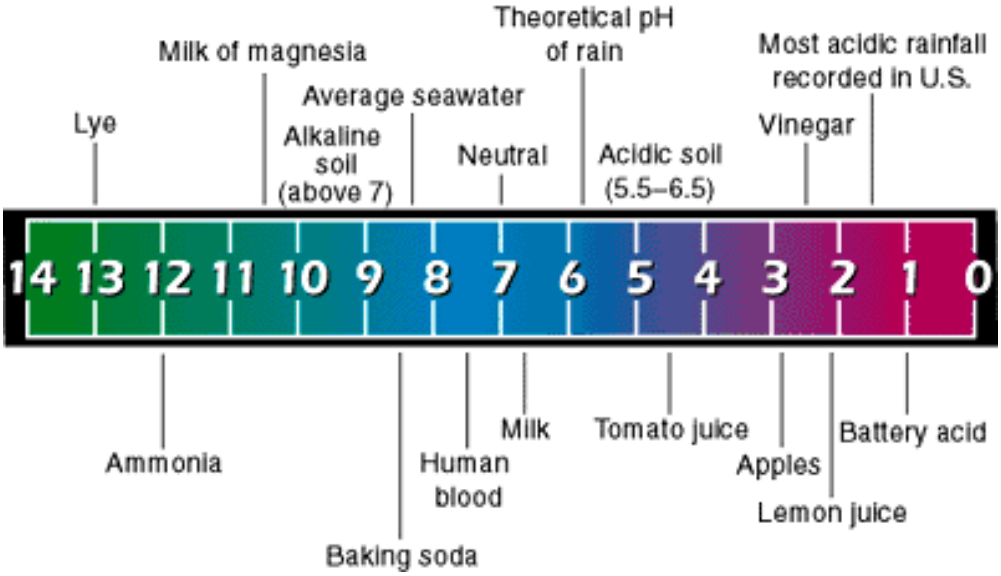
a. Introduction (5 minutes)

Hello, my name is _____. Today we are going to learn about one of the things that must be done to live in the hostile environment of space. On the International Space Station (ISS), where people can live for years at a time, the astronauts must recycle their water. This includes respiration, perspiration, shower and shaving water, and even urine. These wastewaters are purified and then used as drinking water. After we learn about water purification, our Mission Team will design a filter for water purification, as the astronauts would use.

b. Development (10 minutes)

Here on Earth, biological treatments are sometimes used to destroy contaminants in water with microorganisms. The International Space Station uses physical and chemical processes to remove contaminants from water. For example, urine goes through a processor that removes unwanted components in urine using filtration, distillation (a method used to separate chemicals based on differences in their boiling points), and heat disinfection. Less desirable and volatile

components remain as liquid brine, which is returned to Earth and disposed. Water is also checked often to ensure it meets the water quality requirements and monitored closely for bacteria, pollutants, and proper pH (a measure of the acidity of a solution). The pH scale ranges from 0 to 14. *(If using visual aid, indicate pH levels).*



Substances with a pH value of 7, such as pure water, are neither acidic nor basic. A lower pH value indicates higher acidity, and a higher pH value indicates a more basic substance. Public water systems have to meet a pH level of 6.5 to 8.5. Even though the Space Station water system specifications range from 6.0 to 8.5, the recycled water on the International Space Station is almost sterile and much more pure than water from a tap at home or at school. There is no odor or bad taste.

For Space Shuttle missions, it is not necessary to recycle the water or waste products. The Shuttle fuel cells produce water as a byproduct; however, water recycling is imperative for long-duration missions such as the Space Station or possible trips to Mars in the future. There are no fuel cells on the Space Station; therefore water is not produced. In addition, a spacecraft on a lengthy trip to Mars would be limited to the amount of water it could carry because of weight restrictions.

c. Conclusion. (1 minute)

We have now learned some information about the water purification that has to be done on the International Space Station in order to allow people to live in space for long periods of time. We will use this knowledge to design a water purification system of our own.

4. ACTIVITY

WATER PURIFICATION SYSTEM

The mission team is being asked to design a water purification filter like the one used on the ISS. We will build a filter and then test the filter's ability to remove contaminants from water.

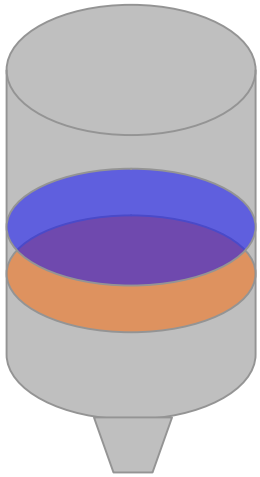
Materials and Tools:

(per group, or Mission Team member)
Clear 2-Liter plastic bottle
Clear glass or other container
Gravel (aquarium)
Sand
Aquarium charcoal (activated)
Cheesecloth or nylon stocking
Muddy water
Rubber bands
Food coloring (optional)
Vinegar (optional)
pH water testing kit (optional)

Procedure:

Note: *This experiment only demonstrates a type of water filtration. The experiment will not purify water for drinking purposes. Do NOT drink the water.*

1. Cut the bottom off the soda bottle. Cover the mouth with several layers of cheesecloth and secure them with a rubber band. Suspend the bottle upside down with its mouth over a clear glass or container to catch the filtered water.
2. Fill the bottle with charcoal to a depth of 5–8 cm. Place 8–10 cm of sand on top of the charcoal. Place 5–8 cm of gravel on top of the sand.
3. Stir the muddy water and pour it into the filter. Watch closely as the water seeps down through the three filtering layers of gravel, sand, and charcoal.



4. Inspect the water that came out to see if the filter successfully removed the contaminants.
5. Ask the mission team the following questions:
   - What happened to the water while it passed through the different layers of the filter?
   - Compare the muddy water to the filtered water. Is there a difference?
   - Would it make a difference if one of the layers had been left out?

Extensions

1. Collect and filter other samples of water containing suspended particles. A clay/water mix or flour/water mix works well.

2. Add a small amount of vinegar to the water mixture and check the pH level of filtered water samples and compare to unfiltered water samples.

3. Filter particle/water mixtures to which food coloring has been added.

4. Design and build a water filter using different materials/layers and compare the results.