SE LASER - STC Kit the STEM Design Challenge developed for : 5th Grade Ecosystems

STEM Design Challenge Project Title: "Portable Water Filtration Systems"

Adapted by: Mike Davis (an original design from NASA)

STEM Design Challenge Project Placement and Pacing

Placement: This activity should be done after the completion of the kit. Lesson 8: Contaminating the ecocolumns should be reviewed before this design challenge.

Pacing: 3 days [1 day to plan/build (60-90 minutes), 1 day to test (60 minutes), 1 day to redesign (30 minutes)].

Common Core State Standards:

Writing: **W.5.2d** – Use precise language and domain-specific vocabulary to inform about or explain the topic (*procedure*)
W.5.2e - Provide a concluding statement or section related to information or explanation presented (*conclusion*)

Math: **5.NBT.3** – Read , write, compare decimals to thousandths (*pH readings*)

Overview: All people need a readily available clean water supply to survive. What if a natural disaster like a tsunami, a hurricane, or a tornado destroyed your area's water treatment plant and your community was left without a supply of clean drinking water. Could you create a portable water filtering system out of common everyday materials?
Students will determine the most efficient filtration material for changing the acidic level of contaminated water ***(gray water – see recipe in materials list)*** .

Objectives:

- Students will be able to use the steps of the Scientific Process to guide their investigation.
- Students will be able to construct an effective filtration system from a list of available materials .
- Students will develop an understanding of the pH scale.
- Students will understand the difference between an acid, a neutral, and a base.
- Students will be able to create a technical drawing of their filtration system.

STEM Design Challenge Problem:
Students will read the "official memorandum" from the ficticious National Disaster Preparedness Network (N.D.P.N.) which asks for help in designing a water filtration system to clean up the water after the recent tsunami that hit the island of Japan. ***(The teacher may choose to change the memorandum to identify a more recent event or an event closer to home.)***
The teacher will mix up a solution of gray water ***(recipe included)*** which will represent the contaminated water. The students' challenge is to design a filtration system using 2-liter bottles

and a variety of possible filtrating materials including gravel, playground sand, charcoal granules, marbles, cotton balls, and Styrofoam packing "popcorn". ***(Teachers may choose to add or delete items from the possible filtrating materials list.)*** The students will then test the pH level of the gray water before and after running it through their filtration system. Their goal is to find the material that will bring the pH level closest to that of normal water which is 5.6 pH.

Materials List:

All materials listed below are provided for each group of 3-4 students

- 4 plastic 2-liter bottles
- 3 cups of gravel
- 3 cups of playground sand
- 3 cups of charcoal granules
- 3 cups of marbles
- 3 cups of cotton balls
- 3 cups of Styrofoam packing "popcorn".
- Measuring cup
- 3 wire screens
  (coffee filters may be substituted)
- Rubber bands
- Clear tape
- Scientific Process Template (one per group)

Material List for "Gray Water"

- **Italian Salad Dressing**
- **Water**
- **Large container**

Italian Dressing and water is mixed 1:5. Teacher will determine how much is needed for each team to have about 500 ml.

Instructional Plan: (Teacher Directions)

1. The day prior to beginning the investigation give students the opportunity to brainstorm what they know about water purifying and water filtration. Class discussion includes listing everyday items found in and around the house that could be used as a water filter such as gravel, playground sand, charcoal granules, marbles, cotton balls, and Styrofoam packing "popcorn". ***(Use the KWL Chart included in lesson.)***
2. The gray water should be prepared the day prior to doing the activity. Determine how much you will need based on your class size.
3. Pass out the official memorandum from the ficticious National Disaster Preparedness Network. Read and discuss orally with class. Allow time for clarifying questions from students. ***(Official Memorandum is included in lesson.)***
4. Go over Background Information page about pH levels and acids, neutrals, and bases. **(*This page is included in lesson.This can be shown on the document camera or make copy for each student. If making copies, make sure they are in color so that the pH Color Chart is properly displayed.)***
5. Have all material displayed on science table for students to pick up when needed. The four plastic 2-liter bottles should be precut by teacher. Each team will need 3 top sections and 1 bottom section. ***(The 3 top sections should measure 25 cm from top of spout to cut area. The bottom section should measure 15 cm from bottom of bottle to cut area.)***
6. Pass out the Scientific Process Template pages. ***(These pages are included in lesson.)*** Each group will need only one copy.

7. Direct each group to fill out their Scientific Process Template before beginning actual construct of filtration system.
   The template should include the following:
   - **Question:** What can I do to make clean water?
   - **Material List:** Each team should create a complete list of all materials they will need to construct filtration system. ***(Advise teams to come back to this list after making their blueprint to make sure their list is complete.)***
   - **Blueprint of Filtration System:** This should be a detailed drawing of their filtration system plan including labels.
   - **Procedure:** This should include all the steps the team plans to take to create their filtration system. ***(There is procedure included in this activity under "Design Criteria." This is to help guide the teacher. It is important that the students create their own procedure. Use the guide to help students make sure their procedure is complete.)***
   - **Data Table:** During the testing of the different filtering materials students should create a data table of the different ph levels that are occurring. Remind students that it is very important to include the beginning pH level of the gray water.
   - **Conclusion:** Each team will collaboratively write a conclusion based on their findings. This conclusion should include which filtering material brought the water to the most acceptable pH level. Also, include information on the materials that were not successful. **(The conclusion will be completed after the investigation has been done.)**
   - **Redesign ideas:** Each team writes down ideas about how they might improve their designs in the future.
8. After each team has completed their Scientific Process Template through the procedure have them bring it up for teacher approval.
9. After the team has received "teacher approval" they may begin to design their filtration system.
10. Include all data generated in their data table.
11. After testing is completed the teams write out their findings in a written conclusion.
12. As a closure activity have each team brainstorm some ideas as to how they could possibly redesign their filtration system to be more efficient.

Resources:

- Ecosystem STC Kit Lesson 8 "Upsetting the Stability"
  - The Story Behind Acid Rain
  - Crops and Cows-What's the Problem?
  - When Salt Isn't Safe

Evidence:

- The students' water filtration system has cleaned the water and brought it to an acceptable pH level.
- Data table
- Conclusion Statements

OFFICIAL MEMORANDUM

To: Finley Elementary Fifth Grade Science Students

From: National Disaster Preparedness Network (N.D.P.N.)

Subject: Portable Water Filtration Systems

Date: November 4, 2011

The recent tsunami that hit the island of Japan was a tragic, devastating event that has had worldwide consequences. Many people lost their homes, properties and even their lives. To compound the problem of personal loss, the drinkable water was contaminated by the countless debris and contaminants. Also, the water treatment plants that normally assure the population of a clean water supply, were damaged by the catastrophic event.

The N.D.P.N. realizes the importance of every household having access to a supply of fresh drinking water even in times of catastrophe like the one in Japan. They would like your help in designing a portable water filtration system that could be made from common, accessible materials found in the home.

You and your team will be provided a variety of common everyday items such as clear plastic bottles, gravel, playground sand, charcoal granules, marbles, cotton balls, coffee filters, packing filters (Styrofoam 'popcorn") and other materials that you may find useful as filtering material.

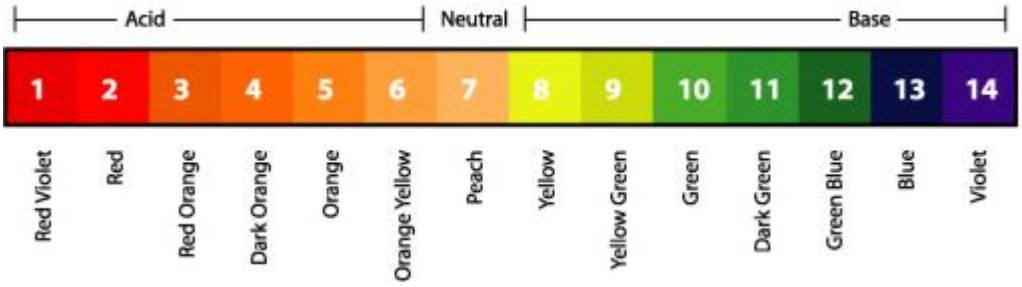
From these materials the N.D.P.N. hope that you and your team will be able to create a efficient filtration system that can quickly and adequately provide clean water to its people.

BACKGROUND INFORMATION:

All water contains some level of acidity. Acidity is measured by pH, which stands for potential of hydrogen. The pH scale measures the amount of acid in the substance. The pH is measured on a scale from 1-14, with 7 being neutral. The lower the number is on the pH scale, the more acidic the substance is. Normal water has a pH of 5.6. When the pH level of water goes below 5.6, it is considered acidic.

When water is at this acidic level it damages everything over a period of time because it makes the living things in the environment die. When water gets polluted living organisms, including people, are cut off of the most essential need in live – clean water.

pH Color Chart



pH Identification Chart

Measure	Type	Examples
Below 7	Acid	• citrus juices such as lemon, orange, or lime • sodas such as cola
7	Neutral	• pure, clean water
Above 7	Base	• toothpaste, baking soda

RECORDING OBSERVATIONS

Use the first column of this **KWL** chart to organize your observations about water recycling and filtration.

Brainstorm with your group what you want to know about water recycling and filtration, then list the results of your conversation in the second column. We will come back to the third column at the conclusion of the activity.

KNOW	WANT TO KNOW	LEARNED

Recipe for Gray Water

- Mix 1 part Italian Dressing (vinegar and oil with seasoning, shaken) to 5 parts water in a large clean container.
- Make enough gray water for each group to have about 500 ml.
- Note the ph of the gray water, it should be around 4. If needed, you can add vinegar to the gray water to drop the pH.

Scientific Process Template pages

QUESTION: What type of filtering system can I design to clean water?

MATERIALS:

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

BLUEPRINT OF FILTRATION SYSTEM:

PROCEDURE:

DATA TABLE:

CONCLUSION:

REDESIGN IDEAS:

What went well with your filtration design?

What parts could be redesigned to be more efficient?

Are there other filtration materials that you could try?

Write down your thoughts and ideas in the area below,