Make Your Own Water Filter

Grade level: 9-12

National Science Content Standards: [1]
A: Science as Inquiry
C: Life Science
E: Science and Technology
F: Personal and Social Perspectives

OBJECTIVE:

To explore the mechanics of filtration and its importance as a health intervention to remove contaminants from drinking water.

DESCRIPTION:

Students will work together as a research team of hydro engineers to design their own water filters. The team will choose a variety of materials and different types of water to test and compare the effectiveness of the filters they have developed.

MATERIALS required per group:

- 2 2-liter clear plastic soda bottle, pre-cut into 1/3 (BOTTOM SECTION) and 2/3 sections (TOP SECTION) See diagram.
- 6 paper cups, label two cups for each type of water below

Materials required for the class as whole:

- 3 clear 2-liter bottles filled with different types of contaminated water: (This is more than enough water to support 8 groups when distributing ½ C per sample to each group.)
  - muddy water ("contaminant" = mud or dirt)
  - turbid water ("contaminant" = Tablespoon of coffee, pastina pasta, or rice)
  - oily water ("contaminant" = 2 Tablespoons of cooking/vegetable oil)

OPTIONS:

Teachers need to decide source of materials. Students may choose filter materials found in one of the three following places: science classroom, homes or hardware store with a pre-determined budget. Materials may include, paper towels, cotton balls, sand, gravel, charcoal, cloth, mesh, surgical gauze.

BACKGROUND:

What if we are thirsty and the only water available is dirty?

Some 4,000 years ago, citizens of ancient India were instructed to heat foul water by boiling and exposing it to sunlight, then dipping a piece of hot copper into it seven times. Finally, they were told to filter and cool the liquid in an earthen vessel.[2] Other ancient civilizations also discovered the benefit of filtering water, but most of their purifying practices disappeared during the Middle Ages, opening the door to plague and pestilence. Over the years, various scientists and

inventors tried their hand at water filtration, but none quite so seriously as Sir Francis Bacon, the British philosopher and scientist. In 1627, a year after his death, Bacon's final work was published (A Natural History in Ten Centuries) detailing thousands of experiments, many of which dealt with water purification methods, including percolation, filtration, boiling, distillation, and coagulation.[3]

Little by little, drip by drop, water filtration became more sophisticated, as scientists learned more about the links between polluted water and disease. Town and city filtration systems using sand emerged in the early 1800s in Scotland. Other communities began to adopt similar methods and evidence supporting water filtration grew. Towns and portions of cities that were fortunate enough to use filtration for water purification had fewer outbreaks and incidences of waterborne disease than communities that did not filter water.[4]

According to the World Health Organization, water-related disease causes more than half the world's hospitalizations, and millions of deaths. Children are the most frequent victims of diarrhea deaths, with thousands dying each day in places like Africa and Asia.[5] Contaminated water can cause disease when used for bathing, drinking or cooking, and can sicken the food supply when the polluted water is used for the watering of crops.

Low-cost solutions can provide safe water and decrease diarrheal disease. Communities that do not have facilities to disinfect and filter their water can use point-of-use water treatment. This simply means treating the water right where it is drunk, either at the source, or in the home. The purpose of a point-of-use water filter is to capture contaminants and prevent filter users from ingesting them. The effectiveness of the water filter is determined by what is known as the pore-size efficiency. This is the measurement of the size of the openings in the water filter. These measurements are microscopic so they can block even the tiniest contaminants, pathogens or parasites.[6]

So, if you are thirsty, and your water is dirty – use a filter! Compete with your classmates to make the finest filter and see first-hand how water filtration has saved millions and millions of lives.

ACTIVITY PROCEDURE:

- Read the **Water Stories Supplement** and learn about Ajia and her home in the Ukambani region of Eastern Kenya.
- Create class water samples: Label and fill three clear 2-liter bottles with water and add one "contaminant" (see above) to each bottle.
- Divide into groups of 4-5 students per group.

  Groups are now teams of hydro engineers and your group is visiting a remote village in the Eastern Province of Kenya. Village leaders inform your team that many village residents have become sick with cholera and dysentery. It is suspected that a tributary of the Athi River where residents collect water for drinking, bathing and household use has been contaminated. In addition to sewage and bacteria, there was an industrial oil spill a few miles upriver. As hydro engineers, your job is to create a device that will filter out the impurities in the river water.
- Each group receives two pre-cut clean 2-liter bottle (see above), a set of group materials (listed above) and the "**Water Filter Blueprint Worksheet**". Each group should either rotate the role of data recorder, or have individuals record group results on their sheets.

- Students will need to work together to determine what materials they wish to gather for their filter. **If materials are to be collected from homes or elsewhere outside of school, students will need two days for activity; one to decide on and collect materials, and a second day to create and test filter.**

STUDENT INSTRUCTIONS:

As a team, determine what five materials you want to use for your filter. Decide where you will find those materials. Bring those materials to classroom.

CREATING YOUR FILTERS:

- Divide the filter materials you bring so you have enough to run the experiment twice. Discuss and decide how your group will build your first filter, including which materials you will use and the order you want to layer these materials in the bottle top.
- Turn the top half of the bottle upside-down like a funnel and place in the bottom half of the bottle (see diagram).
- Layer the first set of materials in the top half of the bottle, starting at the spout (which is facing down). Using the bottle filter diagram (blueprint) on the Worksheet, draw your filter design, making sure to label the materials you used on your blueprint.
- Label 2 cups for each type of "contaminated" water to be used; one will serve as the dirty sample to be filtered, and the other cup will hold the "filtered" water from that same contaminated source. Fill the first set of cups halfway from the appropriate contaminated liter bottles

TESTING YOUR FILTERS:

Follow the instructions below to test your first design. Each group will use its filter to test a water sample from each of the 3 different types of water available (muddy, turbid or oily). Be sure to test one sample at a time and record the results before starting the next test:

- Pour your group's muddy water sample into the large open end of filter design #1 and let the water seep down through the filter layers into the bottom section of the bottle. **Observe** and **record** your filter results on the group worksheet. Pour that filtered water into the **clean cup** labeled "filtered muddy water" and save. **Rinse** bottom of the bottle before resuming the testing.
- Repeat the steps above first with the turbid sample, then oily sample. <u>Be sure to record your results and then rinse bottom of bottle between each test round.</u>
- Analyze the filtered samples, using the form below to determine how effective the filter was with each type of contaminated water. Discuss **what worked** and **what you would change** for the next design round.
- Compare first filtered samples with other teams.
- Repeat design steps above with your new (second) design. Repeat the testing and observation steps, recording your **filter design #2** and results in the space provided.

REFLECTION:

- Report back to the rest of the class what materials you used in your filter, how effective your design was and which resulting samples had the greatest clarity (were the clearest).

- What other items might you use to build a filter?

VARIATION:

When Torben Vestergaard Frandsen created his first water filter, he used cloth – both because he was in the textile business, and because fabric serves as an effective filtration material. Women in many parts of Asia wear Saris made out of silk or a similar synthetic. Because it is widely available, families sometimes use Sari fabric to filter their water.

INSTRUCTIONS:

Conduct the experiment using different types of fabric. Cut 2 yards each of sari (synthetic silk) cloth – if available – nylon cloth and cheese cloth into into 8 ½ x 11 squares. Have each group take at least one square of each material. Cover the bottom half of the soda bottle (the half that looks like a bowl) with one or more of the fabric squares, put a rubber band around the opening of the bottle to secure the material in place, then pour one water sample over the covering to test the filter. Record the results, remove the fabric and empty the water. Rinse the filter bottom with clean water and repeat the test with a different water sample.

EXTENSION:

- Before and after filtration, conduct water quality monitoring. Measure parameters such as pH, nitrates and dissolved oxygen.
- Filter out other contaminants: grass and leaves, pieces of shredded paper, etc.

ENDNOTES:

[1] Education World (2008) *U.S. National Education Standards*. Retrieved March 10, 2012, from http://www.education-world.com/standards/national/index.shtml.

[2] The Journal of Preventive Medicine, By Royal Institute of Public Health (Great Britain) Volume 13, page 379. http://books.google.com/books?id=BNwDAAAAYAAJ&pg=PA379&lpg=PA379&dq=

[3] History of Environmental Engineering: *Environmental Engineering; "One of World's Oldest Professions" by Charles A. Buescher Jr., PE, DEE. Washington University in St. Louis,* Department of Energy, Environmental & Chemical Engineering: http://eece.wustl.edu/aboutthedepartment/Pages/history-env-eng.aspx

[4] *"A Century of* Water," p. 44, by Edward H. Winant, Ph.D., PE, NESC Engineering Scientist. http://www.nesc.wvu.edu/ndwc/articles/ot/su05/OT_su05_History.pdf

[5] "Water and Development, The Health Connection." WHO World Water Day Report; http://www.who.int/water_sanitation_health/takingcharge.html

[6] How Stuff Works: "How Water Filters Work:" http://adventure.howstuffworks.com/outdoor-activities/hiking/water-filter1.htm

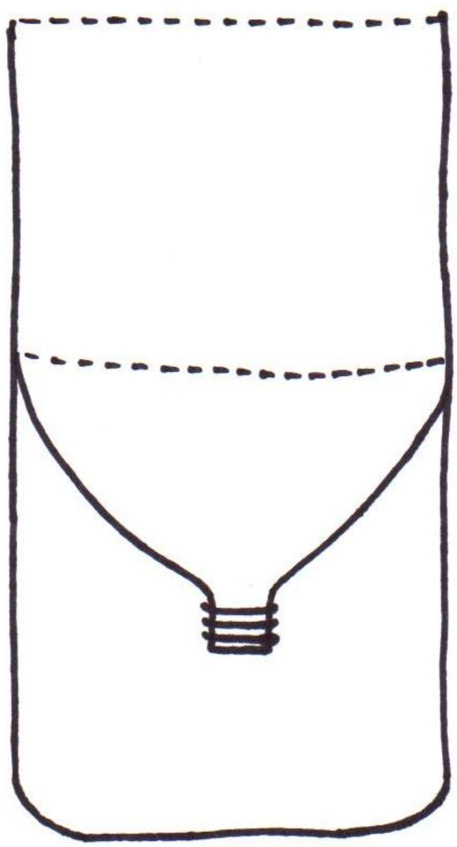
Making Your Own Water Filter: Water Filter Blueprint Worksheet

Group Members: ____

TESTING YOUR FILTERS:

Follow the instructions below to test your designs. Each group will use its filter to test a water sample from each of the 3 different types of water available (muddy, turbid or oily). Be sure to test one sample at a time and record the results before starting the next test.

- Pour your group's muddy water sample into the open end of the bottle and let the water seep down through the filter layers into the bottom section of the bottle. **Observe** and **record** your filter results on the group worksheet. Pour that filtered water into the **clean cup** labeled "filtered muddy water" and save. **Rinse** bottom of the bottle and wipe with paper towel before resuming the testing.
- Repeat the steps above first with the turbid sample, then oily sample. Be sure to record your results and then rinse bottom of bottle in-between each test round.
- Analyze the filtered samples, using the form below to determine how effective the filter was with each type of contaminated water.



BOTTLE DESIGN #________:

Layer 5: ______________________

Layer 4: ______________________

Layer 3: ______________________

Layer 2: ______________________

Layer 1: ______________________

Making Your Own Water Filter: Water Filter Blueprint Worksheet **(cont.)**

QUESTIONS:

1) Examine each water sample. Was your filter effective - do any of your filtered samples appear clearer (less turbid) than the original contaminated samples? Circle one: YES or NO

2) If it was effective, which filtered sample(s) appear the cleanest/most clear? In order of clarity, number the samples 1-3 below, 1 being the clearest:

   Muddy ________________

   Turbid ________________

   Oily ________________

3) How do you explain your answer in Question #2? Was the filter more effective blocking out a particular contaminant over another? Why is that?

   ____

   ____

4) Would you drink any of the samples? Why or why not?

   ____

   ____

   ____

5) How would you re-order your filter materials to make it more effective? Explain your reasoning.

   ____

   ____

   ____

   ____

6) If you could remake your filter using materials other than what was available, what would you use? Explain.

   ____

   ____

   ____

   ____

   ____