TEACH Engineering Resources for K-12

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TE Activity: Straining out the Dirt

Summary

In this activity, students build a water filter with activated carbon, cotton and other materials to remove chocolate powder from water.

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Engineering Connection

Environmental and civil engineers design complex systems to process a community's water supply to make it safe for people to drink. Depending on the quality of water to begin with, most water treatment systems involve many steps to get rid of contaminants that make people sick. Engineers often use filters of sand and activated carbon to remove particulate matter and certain bacteria just before the water is disinfected with chlorine.

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Grade Level: 7 (6-8)
Time Required: 50 minutes
Group Size: 4
Activity Dependency :None

Expendable Cost Per Group : US$ 3.50
Keywords: water, filter, drinking water, pollution, public health, environmental engineer
Reviews: Read Reviews | Be the First to Write a Review

Related Curriculum :

subject areas	Earth and Space
curricular units	Environmental Engineering
lessons	You Are What You Drink!

Educational Standards :

Colorado Science

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Learning Objectives (Return to Contents)

After this activity, students should be able to:

- Predict the effectiveness of different filter layers on removing particles and color.
- Describe the layers present in a model drinking water filter.
- Design and build a model filter and compare it to processes used by engineers in drinking water treatment.
- Test and make observations on filter effectiveness.
- Use data from observations to construct a reasonable explanation of drinking water treatment through a filter.
- Describe how drinking water filters can help improve the drinking water quality of a community.

Materials List (Return to Contents)

Each group should have:

- 0.5 liter (500 mL) plastic water or soda bottle
- ½ cup granulated activated carbon (GAC) (available from chemical supply stores or pet supply stores in the aquarium section)
- 2-3 cotton balls
- Jar (smaller in diameter than the 500 mL bottle so that the water bottle can be supported in the jar without falling through)

For the classroom to share (and teacher to use):

- Drill with small diameter bit
- Kitchen knife or scissors
- 3 tsp. of chocolate powder mix (such as Hershey's® or Nestle Quik®)
- Water (enough water for each bottle to be filled up 3-4 oz.)
- Pitcher or bucket for mixing powdered chocolate and water
- 4-5 cups of sand
- 50+ marbles

Introduction/Motivation (Return to Contents)

How many of you know someone who filters their tap water? How many of you know someone who buys bottled water? Have you ever been in the woods or mountains and drank water from a river after being filtered by a small pump? Why do we do this? Does the water look contaminated? (Answer: sometimes, yes) Unfortunately, *naturally pure* water does not exist. All water sources carry small particles that have been absorbed or dissolved in the water as it passes over river beds, rocks and soil.

In the early 1900s, the United States government began requiring specific levels of cleanliness for drinking water. These regulations did not become strict until the Safe Water Drinking Act of 1974, which then underwent changes in 1986 and 1996. This law tells us exactly which drinking water standards our states must meet to provide safe and healthy drinking water to our homes and communities. The U.S. Environmental Protection Agency (EPA) has set standards for over 80 contaminants that may get into our drinking water and make us sick.

Today, we are going to investigate drinking water filters. We are going to take a sample of muddy water and use the available materials to clean up the water as much as possible. If available, bring a Pur® filter and ask the students if they know what it is composed of; tell them that they will prepare their own Pur® filter for "muddy" water.

Procedure (Return to Contents)

Before the Activity

1. With a straight knife or a pair of scissors, cut off the bottoms of each empty 0.5 liter bottle and discard.
2. Using the drill, make two holes in each bottle screw top. Although this step is not required, the water flow will be slower which will create less mess in the classroom.
3. Prepare a mixture of "dirty" water by mixing two or three teaspoons of chocolate powder and the cold water in the pitcher. Don't worry if the powder makes lumps at the top of the mixture.
4. Construct one or two filters as examples: turn one plastic bottle upside down, with the cut

opening to the top, and place a cotton ball in the lid. Screw the lid back onto the bottle. This filter can be used as the control filter for students, by pouring the mixture into the bottle and watching the chocolate/water mixture pour out. Create another filter the same way, but add whatever mixture of cotton, sand and marbles that you would like to the filter.

With the Students

1. Separate the class into groups of 4 to 5 students. Explain to the students that they are going to be environmental engineers designing a water filter for a drinking water treatment plant. Tell students that their goal is to use any combination of the available materials to make the cleanest water. However, they must each have a cotton ball in their bottle lid.
2. Have students make predictions on which filter layer will be the most effective at cleaning the water and why.
3. When each group has finished creating their filters, pour about 2" thick (approximately ½ cup) of granulated activated carbon (GAC) on the top of their layers. Now the filters are ready to be used.
4. Have students place their filters with the caps downwards on the top of their glass jars.
5. The teacher should pour the chocolate mixture into the prototype filters for each group. Students should observe the "clean" water move from the bottom of their filter into the jars. When the filtration is done, ask students to take their jars and filters to a location where light can illuminate the new mixtures. What happened to the water when it was filtered? (Answer: It turned clearer, less water was remaining, etc.)
6. Have the class vote on who created the filter that cleaned the water the most. If time allows, try to have a discussion on why the winning filter was the most effective, and possible ideas to make the filter even more effective the next time.

Safety Issues (Return to Contents)

The teacher should pre-cut and pre-drill the bottles, rather than allowing the students to handle the knife and drill.

Troubleshooting Tips (Return to Contents)

If you cannot find granulated activated carbon (GAC) in chemical stores, carbon for aquarium filters sold at pet shops can be used.

You can add other filter materials for students to use, including paper towels, coffee filters and gravel.

Assessment (Return to Contents)

Pre-Activity Assessment

Know / Want to Know / Learn (KWL) Chart: Before the lesson, ask students to write down in the top left corner of a piece of paper (or as a group on the board), under the title *Know*, all the things they know about **drinking water filters**. Next, in the top right corner, under the title *Want to Know*, ask students to write down anything they want to know about **drinking water filters**. After the lesson, ask students to list in the bottom half of the page, under the title *Learned*, all of the things that they have learned about **drinking water filters**. Ask students to name a few items and write them on the board.

Activity Embedded Assessment

Drawing: Have the students draw a picture of their drinking water filter. Ask them to draw the different layers in their picture and try to name the layers as well as what particles that layer will remove as best they can. Inform them that this is what an engineer would do when deigning a new product.

Post-Activity Assessment

Know / Want to Know / Learn (KWL) Chart: Finish the remaining section of the KWL Chart as described in the Pre-Lesson Assessment section. After the lesson, ask students to list in the bottom half of the page, under the title *Learned*, all of the things that they have learned about **drinking water filters**. Ask students to name a few items and write them on the board.

Show and Tell: Have the students "show and tell" to the rest of the class the filters they created, explaining their work to the other students. Ask the students to compare each others' filter and brainstorm of other materials or construction order that they could use to improve their filter.

Re-Design Practice (if time allows): Have the students list any design or fabrication changes they would make to their filter on a piece of paper or in their journal. They can also draw a picture of their new design. Emphasize that engineers often re-design their products several times before getting it right.

Student-Generated Questions: Have each student come up with one question of their own about filters and/or drinking water to ask the rest of the class. Be prepared to help some students form a question. If the answers to the questions are not available, encourage the students to search the EPA (http://www.epa.gov) website and to bring those answers back to the classroom to share with the other students.

Activity Extensions (Return to Contents)

Slice open a Pur® (or other type of) filter for students and have them study the components in it. Discuss with the students the concept of adsorption (capability of a solid to attract to its surface molecules of other solid or gaseous materials).

Activity Scaling (Return to Contents)

For 6th and 7th grade students, do the activity as is.

For 8th grade students, have each team filter water using a different individual layer (investigate with sand OR marbles, etc.). Each team should record their observations of that type of filter on a group chart on the board. From the different observations of filter ability, students can reason why they choose the layers of materials that they did for their final filter. (For example, maybe marbles will produce darker filtered water because they let fine particles pass through; however, coupled with sand that did not let fine particles through, this may be a good combination for a final design.)

Owner (Return to Contents)

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