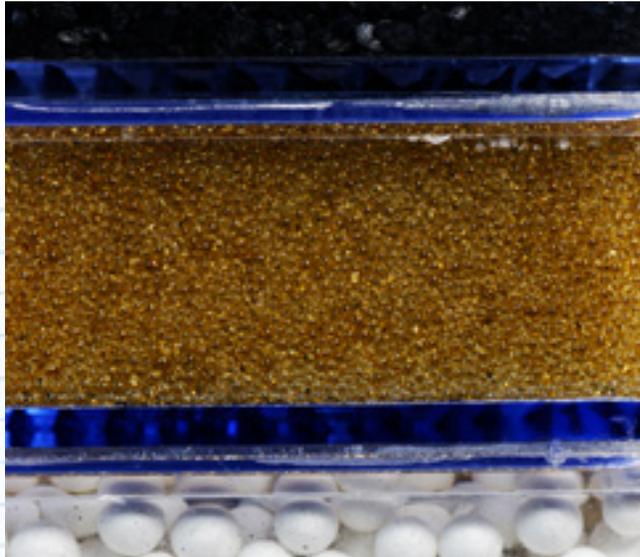


SCIENCE FAIR CENTRAL

Maker Corner Activity



CLEAN WATER ANYWHERE

Grade Level: Middle School

MAKE. CREATE. EXPLORE.

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Clean water is vital to human life.

Overview

Did you know that at least 60% of an adult human body is made up of water? Water is so vital to human life that humans can go for three weeks without food but can only survive for about three days without water!¹ Despite this, three in ten people today lack access to safe drinking water at home.² In this activity, students will learn about the importance of drinking clean water for a person's health, and they will become aware of the water crisis that affects millions of people around the world. They will work together to build and test a portable water filter using simple materials. They will then brainstorm how the design of their water filter could be improved and made into a product that could help those who do not have easy access to safe drinking water.

This activity focuses on **Designing Solutions, Creating or Prototyping, Refine or Improve, and Communicating Results** stages of the Engineering Design Cycle.

Engineering Design Cycle

- Defining the Problem
- **Designing Solutions**
- **Creating or Prototyping**
- **Refining or Improving**
- **Communicating Results**



Objectives

Students will be able to:

Design, build and test a usable water filter
Evaluate how to improve its design
Assess and present how the improved design could be used to help those without access to clean drinking water



Every organ, tissue and cell in our bodies needs water.

Materials

- Computer or other technology with the ability to project
- Bucket for water and filter waste disposal
- A couple gallons of dirty water (Be creative! You can make dirty water by combining tap water with items from home like vegetable oil, pieces of paper, food coloring, dirt, etc.)

Enough for every four students:

- 2-liter plastic bottle, cut in half lengthwise
- One funnel
- Drop cloths, enough to cover student work areas
- Half of a piece of cloth
- One pair of scissors
- One cup of charcoal*
- 2 cups of sand*
- 2 cups of gravel*
- Water Filter Assembly Handout (2 pages)
- Filter Design Handout

**It's fine to keep these materials in a communal bucket or bag and allow students to help themselves.*

Have you ever wondered . . .

Why water is so vital for human life?

The role water plays in our bodies goes far beyond making us not feel thirsty. Our bodies use water in every organ, tissue and cell to maintain and complete all of its functions. From dissolving nutrients in food and delivering them to our cells, to regulating our body temperature, helping our metabolism flush out toxins, and removing waste – water keeps us alive. Because of the huge role water plays in all aspects of our bodily functioning, it's really no surprise that humans can't go more than a few days without it!¹

What exactly is the world's water situation?

Around the world, 3 in 10 (or 2.1 billion) people don't have access to readily available water that is safe to drink. [This infographic](#) illustrates where people are struggling with contaminated water sources. More than 350,000 children under the age of five die every year as a result of diarrhea caused by unclean water. Children and adults alike also suffer from diseases like dysentery, cholera, typhoid and hepatitis A—all of which can be transmitted through contaminated water and lack of sanitation.

While contaminated water exists worldwide, it is more likely to be an issue in rural areas. More than 260 million people (usually women and girls) walk over half an hour a day to

Three in ten people worldwide do not have readily-available access to safe drinking water.



collect water for themselves and their families. But even then, after walking to collect water and carrying it home again, there is no guarantee that the water will actually be clean or safe to drink.²

In 2010, the United Nations General Assembly declared that access to sufficient water for personal and domestic use is a basic human right. While this declaration doesn't mean that this global problem is automatically solved, it demonstrates that it is a goal the UN will be working towards. In addition, the UN observes World Water Day on March 22nd of every year to recognize the importance of water in social, economic and human development.³

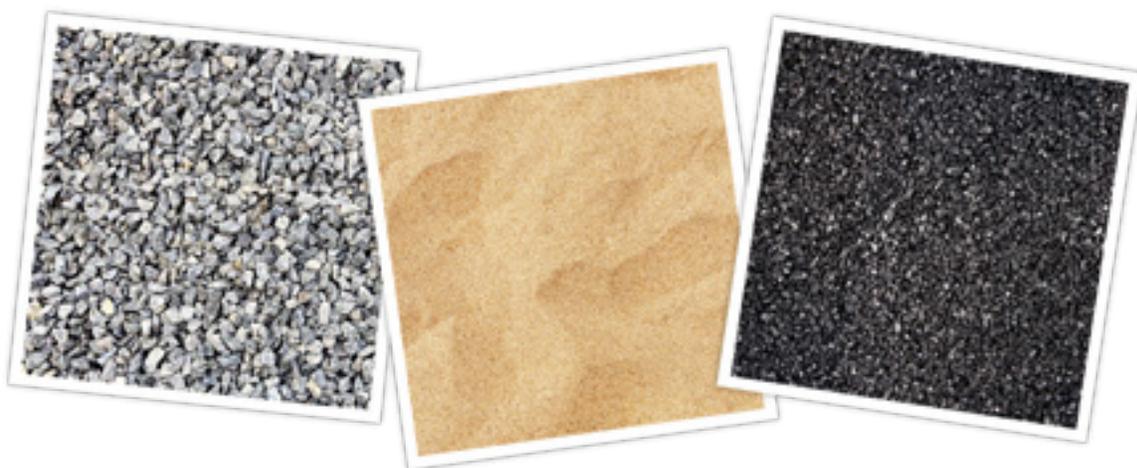
How do simple water filters work?

Water filters are surprisingly simple to make out of mostly natural materials! In this activity, students will create a water filter that uses gravel, sand, charcoal and cloth to purify dirty water.

Students will be tasked with using these materials to design their own filter, but the following design is commonly used:

Within a funnel, the water first passes through a layer of gravel, which will function to filter out large pieces of sediment and waste. Next, the water passes through sand, which will help filter finer sediment and impurities. Third, the water will pass through a layer of charcoal. This charcoal will actually absorb chemicals and further impurities out of the water. Finally, the water will pass through a piece of fabric. This cloth will function to hold back the carbon and let the clean water stream through.

It is important to note, however, that water cleaned this way is not automatically safe to drink. While it is certainly cleaner and safer than it was before, water should always be tested before anyone drinks it.



Water filters are surprisingly simple to make.



Make connections!

How does this connect to students?

You and your students drink water – and beverages made from water – every single day. And beyond just drinking it, water is used for showers, baths, teeth brushing, hand washing, cleaning clothes, washing dishes and more. In fact, it's estimated that the average U.S. citizen uses between 80 and 100 gallons of water...every single day.⁵

When students go camping or travel abroad, access to clean water may not be as easy as it is at home. This activity therefore reminds students that water—especially clean drinking water—is not something that everyone can take for granted!

How does this connect to careers?

Hydrologist—A hydrologist researches the effects of different types of water on public health. They also work in countries with water shortages to develop plans to increase their water supply.

Health Inspector—Health inspectors work for government agencies to ensure that organizations are following safety and health regulations, including rules regarding water used for cooking and drinking.

Conservation Scientist—Conservation scientists work to protect natural resources such as water. They help ensure water is available for public use without harming the environment.⁴

How does this connect to our world?

Countries around the world have varying degrees of access to safe drinking water. Developed countries often don't have to worry about their water sources. Yet in developing countries around the globe, when and where families can find water can be a daily source of worry. Every day, more than 263 million people carry large containers for more than half an hour simply to bring water back to their homes. Oftentimes, this water is still unclean despite the effort it takes to obtain. It's therefore important to understand the clean water issues that much of our world continues to face, as well as possible steps that can be taken to help the situation.



Blueprint for Discovery

Prior to class arriving:

- Cut every soda bottle in half. (See the Materials list for a diagram.) Make sure you keep the halves together, as students will be using both sections.
- Prepare the dirty water, following the directions given in the Materials list.
- Display the rest of the filter materials in an area of the room that is easily accessible to students
- On a white board or a large piece of paper, write in big letters: “Throughout your day, what do you use water for?”
- Photocopy the *Build a Water Filter* and *Filter Ad Template* handouts

During class:

Part 1

1. Begin class with a quick share: From the time you wake up to the time you go to bed, what do you use water for? Record student answers on the board.
2. Lead students in discussing which tasks would be affected if the water was dirty or unclear. How may this change their day-to-day lives?
3. Share [this video](#) (stop at 1 minute 17 seconds) and ask students to be ready to share their initial reactions once the video is complete. Ask: Why is clean water so important? Note: There are many videos created by aid organizations that highlight personal stories about the water crisis. If you're interested, search online for “water crisis videos” and you will have many to choose from.
4. Explain that students will be working in groups to build a simple water filter, with the goal of turning dirty water into clean water. First, they will look at the materials provided and develop a plan for creating their filter. Then, they will test their filter and make a hypothesis about the role each material plays. Finally, they will revise their filter and brainstorm how it could be improved to help people around the world who don't have ready access to clean water.
5. Divide students into groups of four and distribute one Water Filter Assembly handout to each group. Review the directions and the materials that the students will have available to them. Allow students approximately 20 minutes to complete the first page, which consists of building their initial filter and recording their hypotheses.



6. Allow groups time to share their hypotheses and guide them towards the correct answers. (See the explanation under the How do simple water filters work? question if needed.) Students should record each material's actual function on their charts.
7. Direct student groups to turn to the second page of the Water Filter Assembly handout and use the time remaining in class to complete the first step. In this step, they will be asked to redesign and improve their filter based on their observations and their new understanding of each component.

Part 2

1. Using the revised plan that they developed, students should complete the remaining steps on page 2 of their Water Filter Assembly handout, which includes building the second phase of their filter, testing it, and evaluating how it works.
2. After students have completed two trials and have a better understanding of an ideal filter design, take a moment to ensure that students understand that just because the water may look clean, it is not yet safe to drink. Though the water is cleaner, bacteria is invisible. The water would therefore need to be tested before it's safe to drink!
3. Once students understand this, ask them to pretend that their water filter was tested by a professional...and it passed! Now it's time to answer the question: How could their water filter be made into a product to help developing countries?

Part 3

1. Distribute one Filter Ad Template handout to each group. Explain that this template is designed to help them create an informative advertisement about their water filter. They should pretend that this advertisement will be distributed to people who do not have access to clean water. The purpose of this sheet is to demonstrate what their filter looks like, how it works, and why it is important. Be sure to tell students that the filter they include here can differ from the one they tested in their second trial. Encourage them to modify their filter into something they think would work well for these new users.
2. Once the ads are complete, allow students a few minutes to prepare a one-minute presentation to accompany their advertisement. Explain that they will be giving these presentations to the class, but they should pretend that they are presenting them to families who don't currently have access to clean water.



3. As students give their presentations to each other, encourage those in the audience to put themselves in the shoes of those who don't have access to water or those who have to walk far every day to find it. What questions might they have for the presenters?

Take Action

Possible Extension Activities:

1. Students can complete independent research on the world's water crisis, as well as solutions that have already been proposed and/or tried. How could their filter be modified or changed based on this new information? Can students think of anything other than water filtration that may help this problem?
 2. No matter how developed a country is, it is important to conserve water. How can students—as individuals, as part of a family, and as part of a school community—conserve water? After they brainstorm, encourage students to come up with creative ways to share their ideas with their community.
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National Standards

Science

Next Generation Science Standards

MS-ETS1-1

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-3

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



Technology Education

Next Generation Science Standards and International Technology and Engineering Educators Association

Students will develop an understanding of Design. This includes knowing about:

- Attributes of design.
 - Engineering design.
 - The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
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Mathematical Practice

Common Core

CCSS.Math.Practice.MP1

Make sense of problems and persevere in solving them.

CCSS.Math.Practice.MP5

Use appropriate tools strategically.

English Language Arts

Common Core

CCSS.ELA-LITERACY.CCRA.W.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.SL.4

Present information, findings, and supporting zzzzv such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.SL.6

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.



Sources

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2. World Health Organization. "2.1 billion people lack safe drinking water at home, more than twice as many lack safe sanitation." <http://www.who.int/news-room/headlines/12-07-2017-2-1-billion-people-lack-safe-drinking-water-at-home-more-than-twice-as-many-lack-safe-sanitation>
3. United Nations. "Water." <http://www.un.org/en/sections/issues-depth/water/>
4. Learn How to Become. "Careers for Clean Water." <https://www.learnhowtobecome.org/make-a-difference-careers/clean-water/>
5. U.S. Department of the Interior: United States Geological Survey. "Water Questions and Answers." <https://water.usgs.gov/edu/qa-home-percapita.html>



Water Filter Assembly

Directions

To build your water filter, you will be layering charcoal, gravel, fabric, and sand within your plastic bottle. Follow the steps below to begin!

Trial 1

1. Make sure the cap is screwed tightly onto your plastic bottle. Then turn that half of your bottle upside down and place it inside the other half of the plastic bottle, so it looks like the image here. This way, when you remove the cap and pour water into the top, the water will collect in the bottom half.
2. With your group, think about the materials that are available to you and the role they may play in water filtration. Discuss the best way to layer the materials in your filter and create a sketch here. Then build your actual filter!
3. When the water filter is complete, carefully unscrew the cap and place the filter back into the bottom of the plastic bottle. Then pour a small amount of dirty water into the filter. You'll need to pour enough so that the water trickles through the entire filter, but don't pour it too quickly. You don't want it to overflow!
4. Carefully watch as the water streams through the filter. Discuss the filter process with your group and make a hypothesis as to what role each material is playing in the filtration process. If it would be helpful to take your filter apart and examine the materials once the water has trickled through, go ahead! Then record your hypotheses below.

Material	Its Role: Our hypothesis	Actual Job
Gravel		
Sand		
Charcoal		
Cloth		



Trial 2

1. Thinking about your first trial and the actual function of each of the materials, redesign your water filter here.

2. Build your revised water filter and test it. Carefully observe how it works as the water trickles through!

3. How well did it clean the water this time? Is there anything else you would still want to change? Record your ideas below:



Water Filter Ad Template

Additional information that will convince someone without access to clean water to use your filter:

Picture of your filter and explanation of how it works:

Filter name:

