

Activity 3: What is Water? Clean Water Through Filters

One of the interesting things about water is that it can be found in three different states on earth.

- If you heat water to a boil it becomes steam – a gas.
- The water that fills the oceans is liquid. As you purified water in the solar still activity, you were converting the water from a liquid to a gas and back again.
- If you freeze water it becomes a solid – ice.

Water is also a great solvent. That means that things can dissolve in water. When you examined bottled water in Activity 1, some of them had things dissolved in them, such as minerals for flavor. Soft drinks can be carbonated, that is, they contain fizz, which is just dissolved carbon dioxide, or CO_2 . When you open the bottle, the carbonation begins to escape. Have you ever noticed it? Oxygen also dissolves in water – dissolved oxygen is what fish breathe.



Seventy percent of our planet is covered with water. Still, the supply is limited – water must be cleaned sometimes; otherwise we would have nothing but dirty water! Fortunately, the earth is one big water recycling system. Water

moves from the clouds to the earth, soaks into the ground and rises back into to the clouds again in an endless cycle of precipitation, filtration and evaporation.

Humans help this cycle along by cleaning water with filtration plants. We have to, because we dirty so much of it every day! The average American uses about 132 liters (35 gallons) of water every single day for drinking, cooking, washing, in factories, for swimming and many other things. These things dirty the water.

How is water purified? We do it in a way that is similar to the way nature does it.

Think about it! In nature, water filters through soil, rock, sand, gravel, and other layers before it gets to a well. Humans use filters, too -- You can buy water filters for your drinking water for use in your kitchen or when you go camping. If you had to design a water filter, what issues would you need to think about?

NASA Engineering Design Challenge: Make Your Own Water Filter

(credit: Environmental Control and Life Support Systems Water Filtration Challenge. EG-2005-08-96-MSFC)

Design and build a water filtration device using commonly available materials. To meet this challenge, you will build, test, and measure the performance of a filtration device, analyze the data collected, and use this information to work towards an improved filtration design. Be prepared to discuss the process as you go along, and go back and re-do as you discover better ways to filter water.

You will need: (one per device, unless noted)

- 2 half-liter plastic water bottles with the bottom 2-3 cm / one inch cut off. (Many of these bottles have a groove at this point, which may be used as a cutting guide).
- Rubber bands used to attach cheesecloth, window screen, and/or plastic wrap to mouth of water bottle.
- Cheesecloth
- Window screen
- Plastic wrap (enough to wrap)
- Container for filtered wastewater, such as a clear plastic bowl
- Utility knife or scissors
- Masking tape
- Cotton ball
- Coffee filter
- A cup or so of activated carbon (charcoal), rinsed (used in aquariums, available in most pet stores)
- A cup or so of gravel. (Aquarium gravel works best; its color does not matter)
- Sand (play sand works best)
- Oil, dust, sand, hair, salt, and other common things to dirty the water
- Vinegar
- Food coloring (a few drops)

Do Ahead:

Simulated wastewater will take approximately 15 minutes to make and should be done on the morning of the filtration experiment. Each team will need 200 ml of the wastewater. Thus, a 2-liter supply will be enough for 10 teams.

Procedure:

1. Measure the dry materials and place in the container one at a time. Use soil, dust, sand, hair, salt, and other common things you can find.
2. Add 1/2 cup vinegar to the dry materials.
3. Add enough water to make 3 cups.
4. Add 1–2 drops of food coloring.
5. Stir to mix.

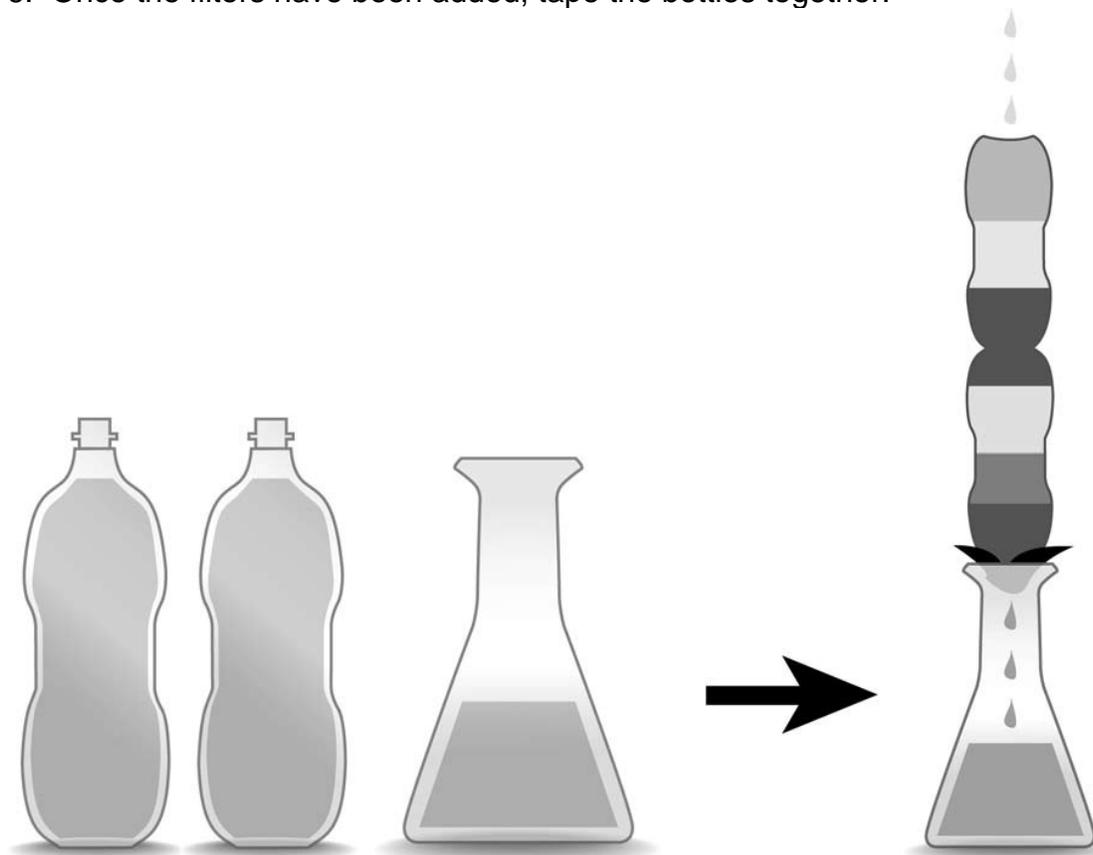
Make Your Filtration Device

Stack the plastic bottles with the mouth of one going into the cut-off bottom of the other. Talk about which filter media – the cotton ball, coffee filter, charcoal, gravel or sand – will do the best job. Choose one or more, enough to fill the bottle. Decide in which order they should be used. What should the water flow through first? Second?

Next, talk about and agree on which material – cheesecloth, window screen, and/or plastic wrap – to use around the mouths of the bottles to slow the filtering and hold the filter media in the bottle. (The two bottles do not have to contain the same filter media nor covering)
Time for this step: About 10 minutes.

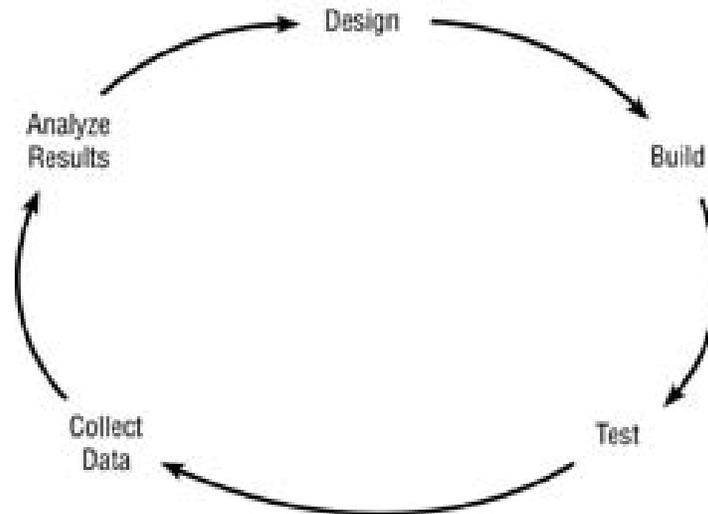
What to do:

1. Remove the labels from two half-liter plastic bottles. Discard the screw caps.
2. Cut 2–3 cm (one inch) from the bottom of each bottle. For most bottles, there will be a groove near this point. Use this groove as a guide even if it is a little more or a little less than the 2–3 cm from the bottom of the bottle. Discard the portion cut from the bottles.
3. Use masking tape to cover the rough edges left from the cutting process.
4. Create layers of filter media in each bottle.
5. Turn the bottles upside down so that the mouth of the bottle is facing down. Stack the bottles on top of each other by placing the mouth of one bottle in the cut portion of the second bottle.
6. Once the filters have been added, tape the bottles together.



Water Filtration Design

Collect materials that you think would make your filter work well. Think about what is in your water and what would be needed to filter each component out. You can use the suggested materials or other material that you think would work well. here is a design process you can use as you design your filter.



After you have built the filtration device, filter your water and examine the results. **Do not taste the water!** Does the water look clean? How does it smell? When you shake it, can you hear debris?

Optional: Lastly pour your filtered water into the **Solar Still** you made in Activity 2 and wait for it to evaporate, condense and collect. What is left in the pan that your filtration device did not catch? Reflect and discuss.

Who sets the standards? EPA vs FDA

In the United States there are two federal agencies that have jurisdiction over drinking water. The U.S. Food and Drug Administration regulates [bottled water](#). The Environmental Protection Agency sets regulations for our [public drinking water](#) systems.

Why do you think FDA regulates bottled water, while EPA regulates public drinking water systems and ground water?

Look at the two Web sites. What do the regulations stress?

Now redesign your filter and see if you can get better results.