

Engineer a Water Purification Filter

Can you invent a water filter that cleans dirty water? You and your teammate will design a water filtration system that will clean dirty water for the community.

This activity has preparation work that should be done before starting!

Materials Required:

For activity itself, we recommend the following:

- Sand
- Gravel
- Cotton balls
- Baking Soda
- Coffee filter
- Activated Carbon
- Napkin
- Sponge scraps
- Tissue
- PH Strips

For prep work:

- A plastic one- or two-liter drink bottle
- Soil
- Vinegar
- Cooking oil
- Food coloring (yellow works best for a “natural” effect, but any would work)

Create “Dirty” Water

1. In another drink bottle (at least 1 Liter), pitcher, or bowl that allows you pour easily, add:
 - a. Heaping tablespoon of soil
 - b. 1 TBSP Vinegar
 - c. 1 TSP Oil
 - d. 1 drop food coloring
2. Add about 4 cups of water and mix it up.
3. Test with PH strip to make sure it's acidic. If not, add more vinegar.

Prepare Filter Bottle

This is usually best done by an adult, as cutting the bottle can be difficult and could result in injury if not done cautiously.

1. Take the one- or two-liter drink bottle and CAREFULLY cut the top off so that it fits into the bottom, as shown at right.
 - a. We've found that cutting using an X-Acto knife, box cutter, or Dremel rotary tool (or similar) with plastic cutter blade works best. If you prefer to use scissors, we recommend first using a sharp knife to cut a slit in the bottle, inserting one blade, and cutting around that way.
2. Take the lid off the bottle – you don't need it for the test.



Disclaimers:

An adult should prepare the filter bottle. Nitsch Engineering is not liable for injuries sustained cutting the plastic.

This water filter is just an experiment and should not be used for drinking water.

Instructions

Can you invent a water filter that cleans dirty water? You and your teammate will design a water filtration system that will clean dirty water for the community.

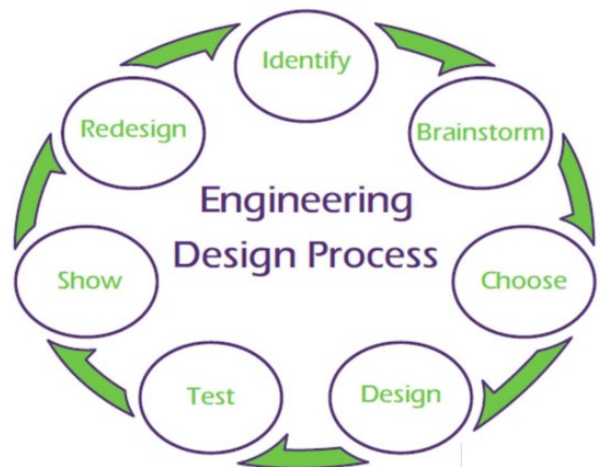
The goal is to clean the dirty water using the available materials while staying within budget.

Each team will be given a budget of **\$20** for the cost of materials and will have **two trials** to design the system.

Materials:

The following materials can be used to filter the dirty water:

- Sand (**\$1 per ¼ cup**)
- Gravel (**\$1 per ¼ cup**)
- Cotton balls (**\$1 for 4**)
- Baking Soda (**\$1 for 1 tsp**)
 - Alkaline additive
- Coffee filter (**\$1 each**)
- Activated Carbon (**\$1 for 1/8 cup**)
 - Removes odors and impurities from water
- Napkin (**\$1 each**)
- Sponge scraps (**\$1 per ¼ cup**)
- Tissue (**\$1 each**)



Directions:

1. Observe the dirty water. What color is it? What happens when you shake it? What does it smell like? Check the pH, what does that pH compare to? Be sure to record your observations on the **attached sheet**.
2. Brainstorm what materials you want to buy with your budget. Make a list of materials using the **attached sheet** and bring to the 'materials store'. *Remember, your budget is for **two trials!***
3. Place the top half of the plastic bottle upside-down (like a funnel) inside the bottom half. The top half will be the filter, and the bottom half will hold the filtered water.
4. Predict what each material might remove from the dirty water. Then layer the filter materials inside the top bottle half.
5. Shake well, then pour the dirty water through the filter. *Remember, your dirty water is for **two trials!*** Set the filtered water aside. What does the filtered water look like? Record your observations on the **attached sheet**.
6. Take apart the filter and look at the different layers. Can you tell what each material filtered from the water?
7. Throw out the filter materials in the designated trash bag. Then wipe out the bottle and try it again. See if you can make the filtered water even cleaner. Try putting materials in a different order of layers. Or try using different materials/quantities.



Clean up! Carefully pour your filtered water back into the bottle with dirty water. Place the plastic bottle filters into the designated recycling bag, and the filter materials into the designated trash bag.

What is the pH of your dirty versus clean water?

Dip your pH strip into the water and match the color from the chart in its package.

What does the pH of the water compare to in your everyday life?



3 Carbonated Water, Club Soda, Energy Drinks

4 Popcorn, Cream Cheese, Buttermilk, Prunes, Pastries, Pasta, Cheese, Pork, Beer, Wine, Black Tea, Pickles, Chocolate, Roasted Nuts, Vinegar, Sweet and Low, Equal, Nutra Sweet

5 Most Purified Water, Distilled Water, Coffee, Sweetened Fruit Juice, Pistachios, Beef, White Bread, Peanuts, Nuts, Wheat,

6 Fruit Juices, Most Grains, Eggs, Fish, Tea, Cooked Beans, Cooked Spinach, Soy Milk, Coconut, Lima Beans, Plums, Brown Rice, Barley, Cocoa, Oats, Liver, Oyster, Salmon

7 Neutral pH
Most Tap Water, Most Spring Water, Sea Water, River Water

8 Apples, Almonds, Tomatoes, Grapefruit, Corn, Mushrooms, Turnip, Olive, Soybeans, Peaches, Bell Pepper, Radish, Pineapple, Cherries, Wild Rice, Apricot, Strawberries, Bananas

9 Avocados, Green Tea, Lettuce, Celery, Peas, Sweet Potatoes, Egg Plant, Green Beans, Beets, Blueberries, Pears, Grapes, Kiwi, Melons, Tangerines, Figs, Dates, Mangoes, Papayas

10 Spinach, Broccoli, Artichoke, Brussel Sprouts, Cabbage, Cauliflower, Carrots, Cucumbers, Lemons, Limes, Seaweed, Asparagus, Kale, Radish, Collard Greens, Onion

Trial Costs

Quantity Trial #1	Quantity Trial #2	Material	Unit Cost	Cost Trial #1	Cost Trial #2
		¼ Cup Sand	\$1.00		
		¼ Cup Gravel	\$1.00		
		4 Cotton Balls	\$1.00		
		1 Tsp Baking Soda	\$1.00		
		1 Coffee Filter	\$1.00		
		⅛ Cup Activated Carbon	\$1.00		
		1 Napkin	\$1.00		
		¼ Cup Sponge Scraps	\$1.00		
		1 Tissue	\$1.00		
		Total Cost			

Water Observations

OBSERVATION TECHNIQUE	PRE-FILTRATION	POST FILTRATION - TRIAL 1	POST FILTRATION - TRIAL 2
COLOR			
CLARITY (Hold the bottle up to the light, what do you see?)			
SMELL			
pH			

Notes:

Visit <http://www.nitscheng.com/about-us/educational-offerings/introduce-a-girl-to-engineering-day> for additional resources and similar event information!