What materials in a homemade water filter work the best to filter water?

Question

What materials in a homemade water filter work best to filter water?

Hypothesis

If I put small materials (materials with small gaps between them) at the bottom and big materials (materials with larger gaps between them) at the top then the water will be cleaner because bigger contaminants will come out at the top and then it is easier for the water to go through the small materials.

Background Research

When certain chemicals pass next to activated charcoal, they attach to the surface and are trapped.

Gravel or small stones are used to filter out large things, and sand is used to filter out smaller things.

You have to heat organic materials with a lot of carbon in them to a very high temperature to make activated charcoal. It increases the surface area of carbon by creating small pores.

An activated charcoal filter will remove some bacteria, toxic things, bad smells, and chemicals while ignoring other things.

There is not one single water filtration method that removes all contaminants from water. Most good water filters use multiple methods together.

4000 years ago, people thought if water was clear it was safe to drink.

There could be a lot of bad things in unfiltered water, like chlorine, heavy metals, chemicals, pesticides, and more.

3% of the water on earth is fresh water but only 0.4% is useable for tap water.

Research from 2017 to 2018 found microplastics in 93% of bottled water and 92% of tap water.

If minerals we need are not removed from the water, and the filter is replaced frequently, filtered water is healthier than tap or bottled water.

Materials

-cotton balls

- gravel

- sand

- pebbles

- thin cloth

- activated charcoal

- coffee filter

- popsicle sticks

- cups

- TDS (Total Dissolved Solids) meter

- coconut shell activated charcoal

- rubber bands

- foam

- Water test strips

Variables

Manipulated
Controlled
Responding

Manipulated variable: The materials in the filter.

Controlled Variable: The bottle that the materials are in, same amount of dirty water, same amount of materials in dirty water.

Responding Variable: The water filter that made the water the cleanest.

Procedure

Step One: Buy cotton balls, gravel, sand, pebbles, activated charcoal, water test strips, a TDS meter, coffee filter, popsicle sticks, cups, thin cloth, rubber bands, and foam. Also get three soda bottles and styrofoam from the recycling or garbage. Get scissors from your home or buy them.

Step Two: Cut the soda bottle in half so the top half is separated from the bottom half.

Step Three: Flip the top half upside down into the bottom half.

Step Four: Use rubber bands to attach thin cloth over the part where liquid comes out.

Step Five: Put sand on top of the cloth. Then put activated charcoal on top of the sand. Then put pebbles on top of the activated charcoal.

Step six: repeat steps two and three for the second bottle.

Step seven: use rubber bands to attach thin cloth over the part where liquid comes out.

Step eight: Put cotton balls on top of the cloth. Then put coconut activated charcoal powder on top of cotton balls. Then put gravel on top of the coconut activated charcoal. Then put ripped up styrofoam on top of gravel.

Procedure

Step Nine: Do steps two and three for the third bottle.

Step Ten: Use rubber bands to attach a coffee filter over the place where liquid comes out. Then put ripped up foam on top of coffee filter. Then put gravel on top of ripped up foam. Then put cut up popsicle sticks on top of gravel.

Step Eleven: Go outside and get mud, dirt, plants, etc.

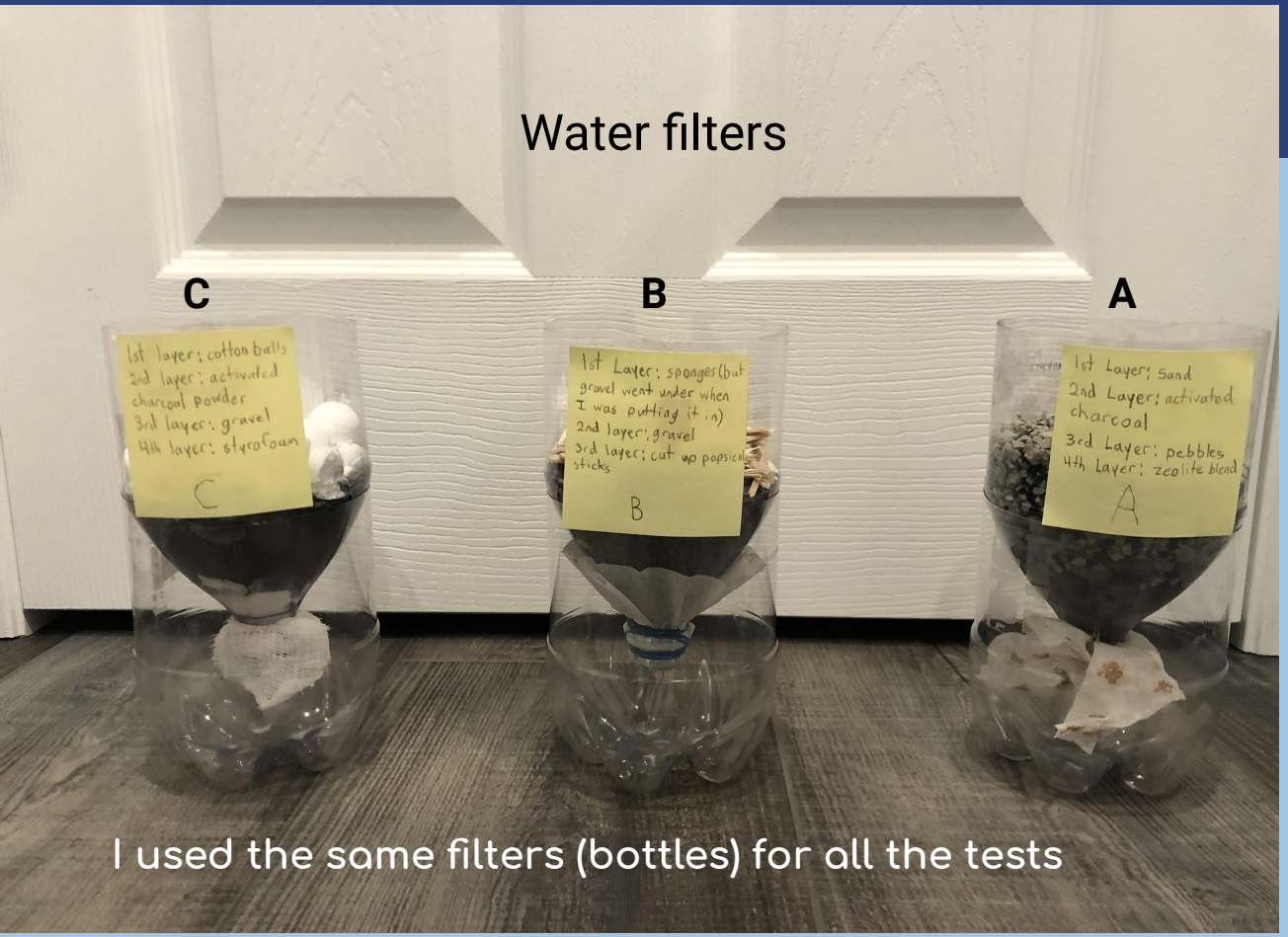
Step Twelve: Go inside, get a cup, and put the things you got inside.

Step Thirteen: Fill the cup with 300 ml of water.

Step Fourteen: Pour the water though the materials in all the bottles and once all the water has gone through, test which one was the cleanest with the TDS meter.

Step Fifteen: Test the water from the filter that had the least dissolved solids with the test strips.

Water filters



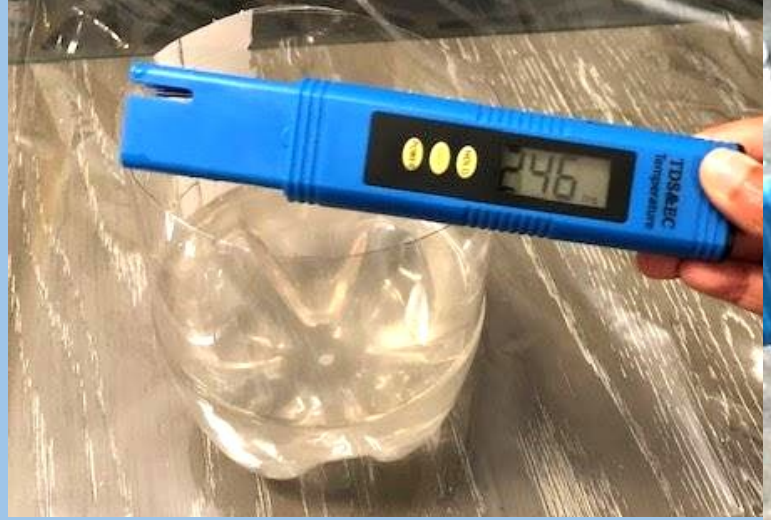
I used the same filters (bottles) for all the tests

Dirty water

Materials in the filters

	Filter A	Filter B	Filter C
1st layer (bottom)	Sand	Ripped up sponges	Cotton balls
2nd layer	Normal activated charcoal	Gravel	Coconut shell activated charcoal powder
3rd layer	Pebbles	Cut up popsicle sticks	Gravel
4th layer (top)	Zeolite blend		Cut up styrofoam

Filter A



Filter B

Filter C

Total dissolved solids meter (From test one)

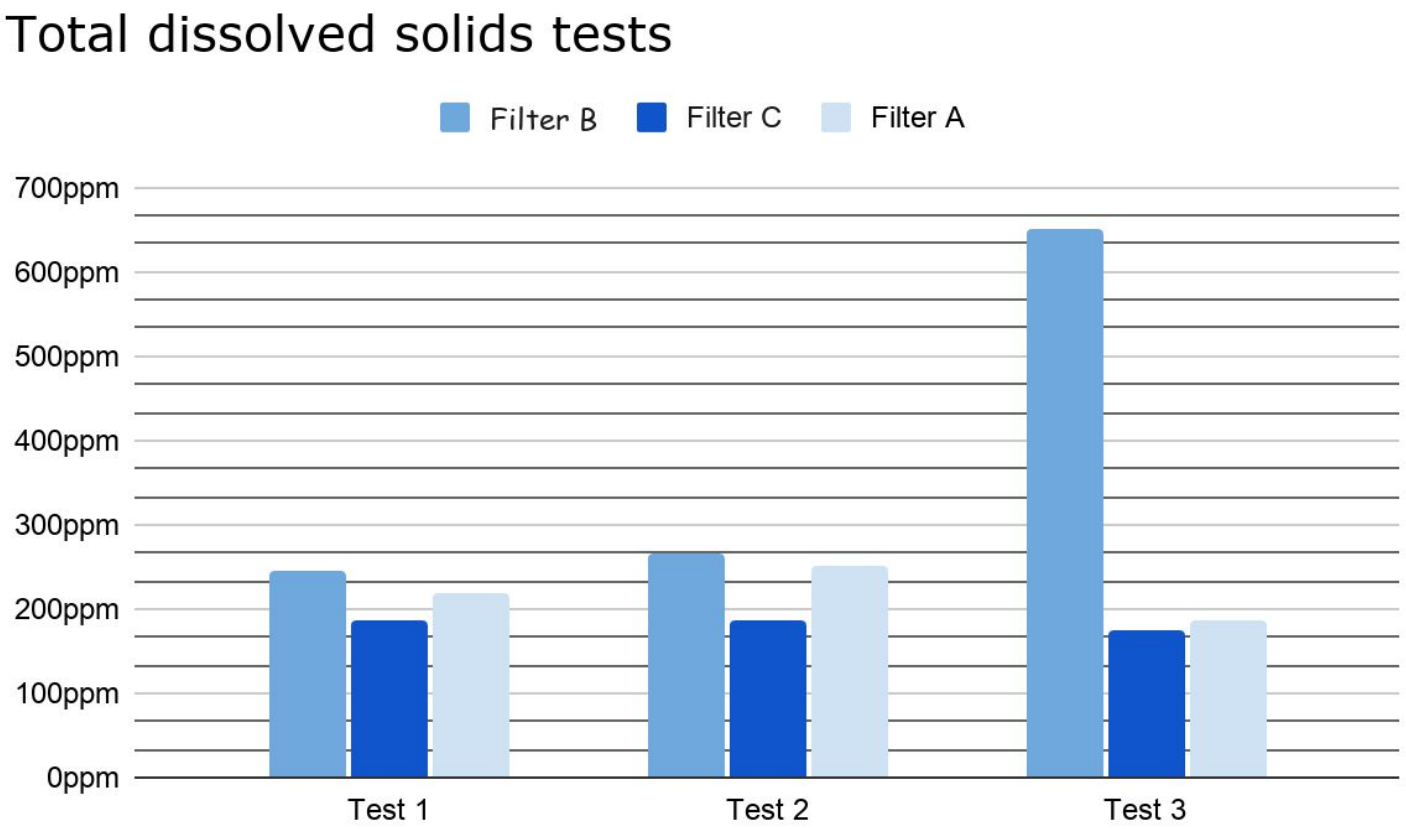
Test Results (for total dissolved solids)

	Test 1	Test 2	Test 3
Filter A	218 ppm	251 ppm	259 ppm
Filter B	246 ppm	265 ppm	652 ppm
Filter C	521/187 ppm	186 ppm	174 ppm

(ppm means parts per million, so it is measuring how much dissolved things are in a million parts.)

The first time I tested filter C it had the most ppm and I was surprised because it was the clearest. But when I looked closely at the water, I could see tiny pieces of activated charcoal powder so that's why it had the most ppm.
I also tested the water again but I put normal cloth instead of cheesecloth and it had 187 ppm.
I think things from the cheesecloth was going into the water and also activated charcoal powder was going through the cheesecloth.

Test dates:
January 3 - January 5

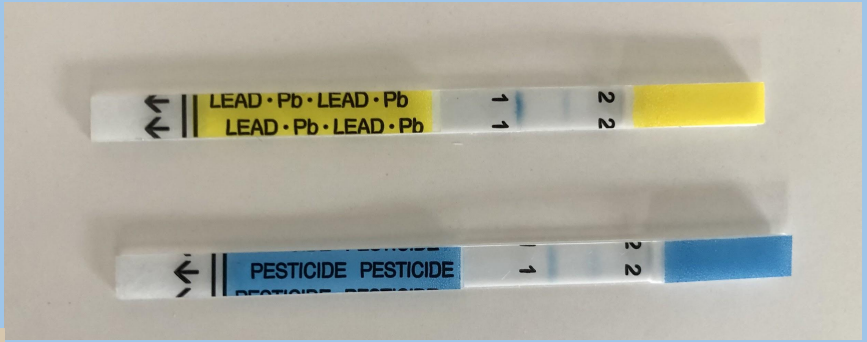


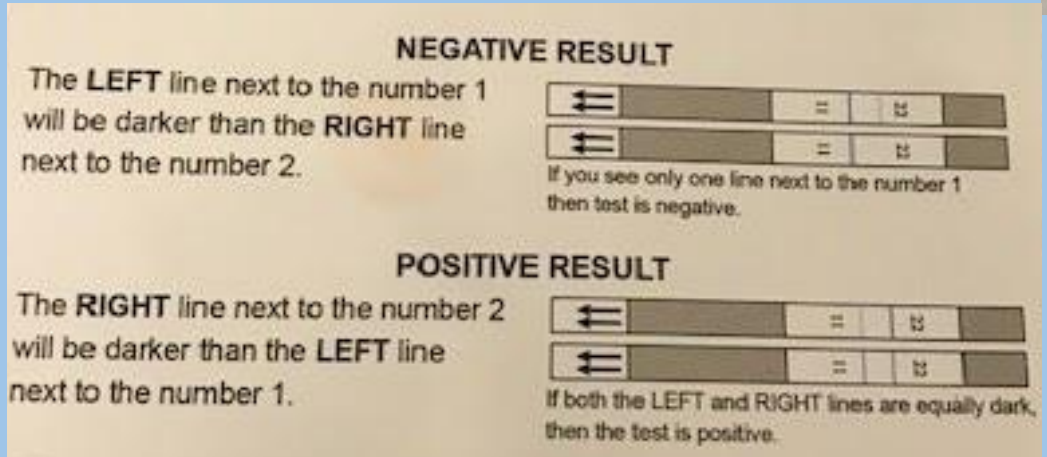
Total dissolved solids bar graph

(ppm means parts per million, so it is measuring how much dissolved things are in a million parts.)

Lead and Pesticides test (for Filter C)

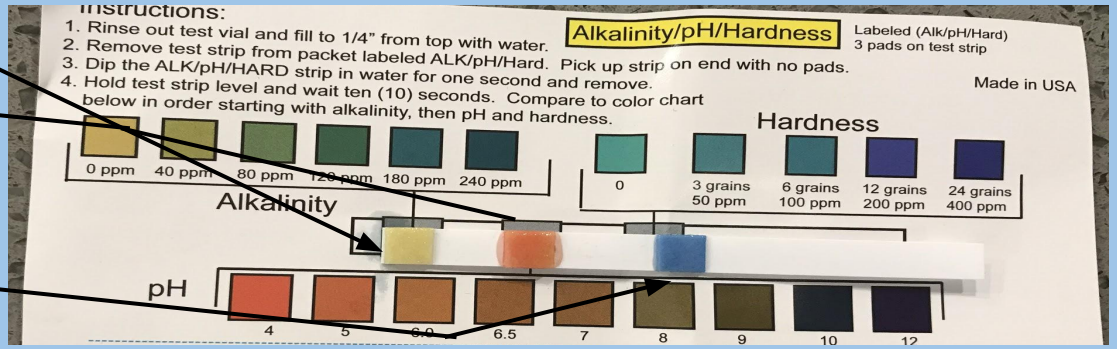
Lead test	Negative
Pesticide test	Negative

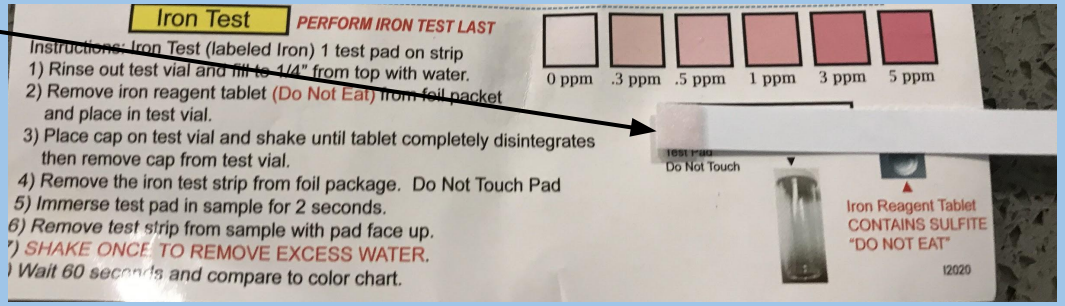




Alkalinity, pH, Iron and hardness tests

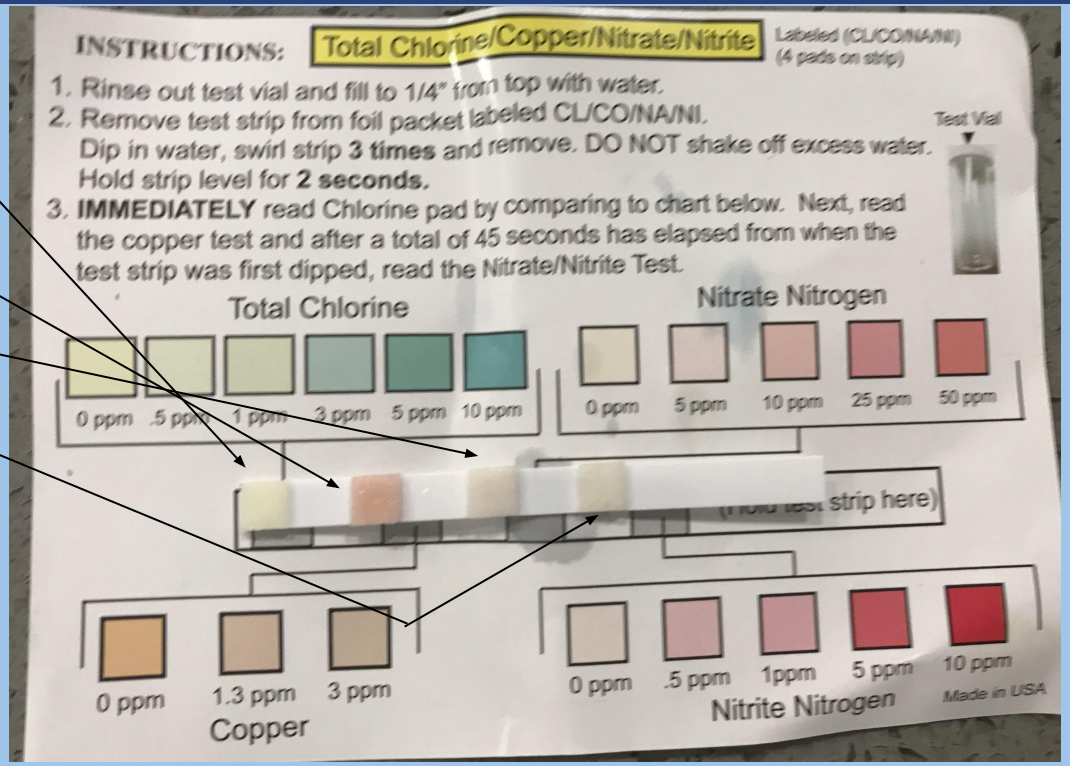
Alkalinity	0-40 ppm
pH	5 (The water is a little acidic)
Hardness	100-200 ppm (Hard water)
Iron	0-0.3 ppm





Chlorine, Copper, Nitrite and Nitrate tests

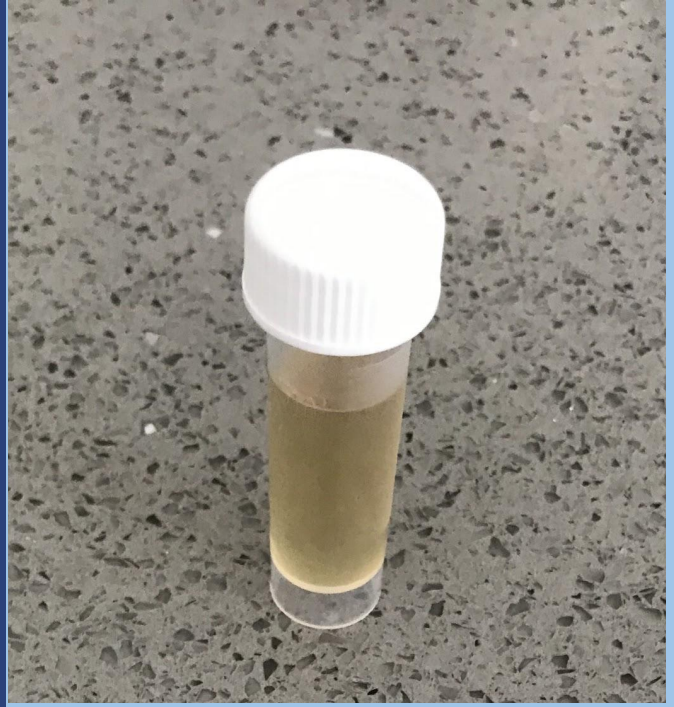
Chlorine	0 ppm
Copper	1.3 ppm of copper
Nitrate	0 ppm
Nitrite	0 ppm



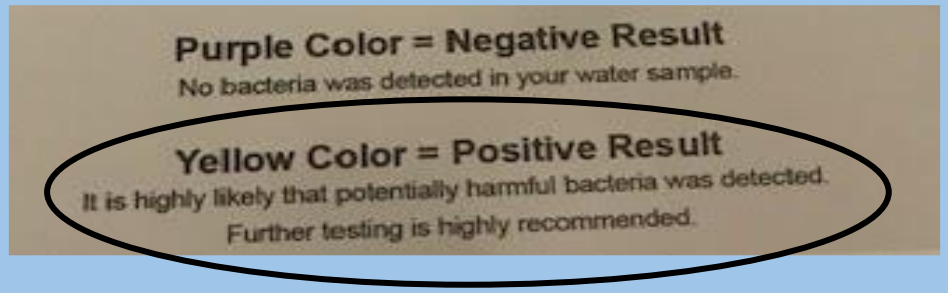
Bacteria Test

Positive

(For filter C)



I think the pH level for the water was low because of the bacteria.



Filter A took the least time to filter the water, and Filter C took the most time to filter.

The ppm for filter A and B's water was going up after each test and the ppm for filter C's water was going down.

Filter B's water looked like it was getting darker and dirtier after each test.
Filter A's water looked like it was getting clearer, and Filter C's water looked the same after the tests and it was crystal clear.

Filter C had the lowest dissolved solids so it filtered the dirty water better than filter A and B. But it can't filter good enough to remove harmful bacteria because the bacteria test was positive.

My hypothesis was correct because I put the small materials at the bottom and the bigger materials at the top for Filter C and the water from it was the cleanest.

Filter A used normal activated charcoal and Filter C used coconut activated charcoal powder so coconut activated charcoal powder worked better than the normal activated charcoal. Because when I researched I learned coconut shell activated charcoal has more micropores, therefore there's less surface area. It absorbs molecules with less density with efficiency.

I also tested bottled water total dissolved solids and it was higher than the water from filter C. That might be from the microplastics and minerals in the bottled water.

Conclusion

Sources of Error

- I didn't have enough dirt for the second test so I had to get more and that dirt might have different things in it.

- There might be different amounts of dirt in each cup of dirty water I put into the filter.

- The water that was already filtered was touching the cloth so particles from the cloth might have gone into the water.

Extension

I would get a lot of dirt and water so I don't run out of dirty water.

I would also pour a little less water in the filters so the filtered water doesn't touch the cloth.

I could get more water test strips and test the water from all of the filters.

I could add more than just dirt in the dirty water, like grass, seeds, and other things.

I could also change the order of the materials in the filters.

Resources

Benefits and uses of coconut shell activated charcoal
https://envirosupply.net/blogs/news/coconut-shell-activated-charcoal-benefits-uses#:~:text=Activated%20carbon%20is%20obtained%20from,most%20present%20in%20well%20water

Homemade water filter science project:
https://science.lovetoknow.com/science-fair-projects/homemade-water-filter-science-project

Which Filtration material leads to the best drinking water?
https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p108/chemistry/which-filtration-material-leads-to-the-best-drinking-water#background

Make a water filter:
https://kids.nationalgeographic.com/explore/books/how-things-work/water-wonders/

How to make a water filter as a science experiment:
https://sciencing.com/make-water-filter-science-experiment-5507017.html

Meet The teen who invented a revolutionary Water filter:
https://www.globalcitizen.org/en/content/14-water-purification-system-internat-science-fair/

Resources

Clean Water STEAM Project:
https://sites.google.com/wayland.k12.ma.us/teamfivesteam/clean-water-steam-project

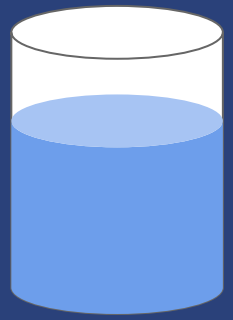
The Dirty Water Project: Design, Build, and Test your own water filters
https://www.teachengineering.org/activities/view/cub_environ_lesson06_activity2

Water Filtration Project: Make Your Own Water Filters
https://www.teachengineering.org/activities/view/water_filtration

How Water Filters Work
https://www.explainthatstuff.com/howwaterfilterswork.html

History of Water Filtration
https://www.haguewaterofmd.com/history-water-filtration/#:~:text=In%20the%20mid%2D1700s%2C%20Joseph,available%20for%20sale%20in%201750.

Resources



What do Water Filters Remove?
https://www.frigidaire.com/Blog/Product-Advice--Education/What-Do-Water-Filters-Remove/

How Water Filters Work and Why You Need One
https://tappwater.co/us/how-water-filters-work-and-you-might-need-one/?

How to make two liter water filter from natural items:
https://www.youtube.com/watch?v=0DlnAq5UAqY

What are the benefits of activated charcoal?
https://www.medicalnewstoday.com/articles/322609#what-is-activated-charcoal

How to test water quality
https://www.wikihow.com/Test-Water-Quality

Water test kit
https://www.amazon.ca/gp/product/B01EUDOFOO/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&