

# The Great Water Filter Challenge: Beyond Charcoal

## Materials Needed:

- Clear 2-liter plastic bottle, cut in half (adult supervision needed for cutting)
- "Dirty Water" mixture (in a separate pitcher or bowl): water mixed with soil, small leaves, grass clippings, and fine sand
- Several large, clear cups or jars (one for the original dirty water, one to collect filtered water, and one with clean tap water for comparison)
- **Filtering Materials (The "Alternatives"):**
  - Gravel or small pebbles (rinsed)
  - Coarse sand
  - Fine sand
  - Cotton balls or cotton batting
  - Coffee filters or paper towels
  - A piece of cloth or fabric (like from an old t-shirt)
- A large spoon for scooping materials
- Notebook and pencil for designing and recording observations

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## Lesson Plan Details

**Subject:** Science, Engineering, Environmental Studies

**Grade Level:** 4th-5th Grade (Age 10)

**Time Allotment:** 60-75 minutes

### 1. Learning Objectives

By the end of this lesson, the student will be able to:

- Design and build a multi-layer water filter using natural materials other than activated charcoal.
- Explain the function of each layer in their filter design (e.g., "the gravel stops the leaves, the sand stops the dirt").
- Observe and record the changes in water clarity after filtration.
- Critically evaluate their design's effectiveness and propose improvements.

### 2. The Lesson: Step-by-Step

#### Part 1: The Challenge is Revealed! (10 minutes)

1. **Engage:** Place the jar of "dirty water" on the table. Ask the student: "Imagine we are on a camping trip and this is our only water source. We can't drink it like this. What makes it dirty?" (Guide them to identify different components like soil, leaves, twigs, etc.).
2. **Introduce the Goal:** "Our challenge today is to become engineers! We need to design and build a device that can clean this water as much as possible. There's a rule, though: we can't use activated charcoal, which is a very common filter material. We have to be creative and use these other natural materials to do the job."

3. **Brainstorm:** Look at the available filtering materials (sand, gravel, cotton, etc.). Ask: "Which of these materials do you think would be best at stopping big things like leaves? What about tiny things like mud particles? Does the order we put them in matter?"

### Part 2: Design and Build (25 minutes)

1. **Design First:** In the notebook, have the student draw their filter design. They should sketch the cut bottle and label the layers of material they plan to use and in what order. Ask them to write one sentence explaining *\*why\** they chose that order.
  - **Helpful Hint:** A good filter usually goes from coarse to fine materials. The water passes through larger materials (like gravel) first to remove big debris, then through smaller materials (like sand) to remove finer particles. A cotton ball or cloth at the very bottom can act as a final screen and hold the other layers in.
2. **Construct the Filter:**
  - Take the top half of the cut plastic bottle and turn it upside down, placing it into the bottom half (which will act as a stand and collection basin).
  - Unscrew the cap, or if it's still on, poke a few small holes in it. This is where the clean water will drip out.
  - Following their design, the student will carefully add their chosen layers of filtering material into the inverted bottle. Use the spoon to help add sand and gravel neatly.

### Part 3: The Test and Observation (15 minutes)

1. **Place your Filter:** Make sure the filter is securely resting in its collection base.
2. **Pour Slowly:** Gently and slowly, pour some of the "dirty water" into the top of the filter. Don't pour too fast or it might overflow or disturb the layers.
3. **Observe:** Watch as the water trickles through the layers. What do you see happening? Is the water coming out of the bottom cleaner?
  - Set up three cups side-by-side for comparison: the original dirty water, the newly filtered water, and the clean tap water.
4. **Record Results:** In the notebook, have the student describe the results. How clear is the filtered water compared to the original? Was the filter successful? (Note: Remind the student that this water is *\*cleaner\**, but it is **still not safe to drink** without boiling or chemical treatment, as filters don't remove microscopic germs!)

### Part 4: Reflect and Redesign (10-15 minutes)

This is the most important part for critical thinking! Discuss the following questions:

- Which layer do you think did the most work? Why?
- If you could build a second filter, what would you do differently? Would you change the order of the layers? Add more of one material? Use something new?
- Why is it important for people to know how to clean water using simple, natural materials? (Connect to survival, history, and communities without access to modern technology).
- We didn't use activated charcoal today. Charcoal works by having millions of tiny pores that trap very, very small impurities. How did our materials work differently? (Guide them to the idea that their materials worked by physically blocking particles of different sizes, like a sieve).

### 3. Differentiation and Extension

- **For Extra Support:** Pre-layer the first two materials (e.g., cotton and sand) and have the student decide on the final, most important layers. Talk through the logic of "coarse to fine" before they

begin designing.

- **For an Advanced Challenge:**

- **The Budget Challenge:** Assign "points" to each material (e.g., Gravel = 1 pt, Sand = 2 pts, Coffee Filter = 3 pts). Give the student a budget of 10 points to "buy" materials for their filter. This forces them to make strategic choices.
- **The Second Draft:** Have the student build a second, improved version of their filter based on their reflection and test the two versions against each other to see which works better and faster.