Engineering Activity 4: Block It Out: Investigating Filters

Educator Preview

Activity Snapshot

Learners investigate the ability of various filter materials to remove contaminants from a water sample.

Timing | 45 minutes

Get Ready & Team Up	10 min.
Investigate	25 min.
Reflect	10 min.
Total	45 min.

Level Up Activities 5–20 min. each

Prep Snapshot*

Prep Time 40 min.

- Space Need: Sink
- Make Filter Bases.
- Set up Materials Table.
- Create chart.
- Prep charcoal filter.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Habits of Mind

- Investigate properties and uses of materials.

Guiding Question

How can we improve water quality?

Learners Will Do

Test the effectiveness of at least one filter material for cleaning water.

Learners Will Know

Engineers investigate how well materials filter contaminants from water so they can design solutions for places with limited water.

Connecting Across Activities

Activity 3: Investigating Water Quality	Activity 4: Investigating Filters	Activity 5: Investigating Reuse Process
Last time, learners measured the water quality of the samples they had made.	**Today**, learners investigate the ability of various filter materials to remove contaminants from a water sample.	**Next time**, learners will apply what they learned about water quality to reconfigure a model building to reuse as much water as possible.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction, pgs. iii–xxvi. Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/f804712f

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) in Prep & Setup Guide (PDF) Examples & Template
- chart paper and markers
- 1 foil tray, 12" × 12"
- 1 plastic container with lid, 8 oz.
- 1 roll of paper towels
- 1 roll of painter's tape
- 2 rubber bands
- 1 safety glove
- 1 strainer
- 1 utility knife
- 1 vial of food coloring, yellow
- 2 Tbsp of activated charcoal
- 2 pieces of cheesecloth, 12" × 12"
- 7 two-liter bottles
- towels or disposable tablecloths (optional)

For the Materials Table

- 1 measuring cup, 1/4 cup
- 1 cup of limestone gravel
- 2 cups of sand
- 2 tablespoons
- 8 half-sheets of paper towel
- 18 pieces of cheesecloth, 12" × 12"
- 20 rubber bands
- 40 cotton balls
- 60 plastic cups, 8 oz. (optional)

For each learner

- Engineering Notebook (PDF)

For each group of 4

- 1 coffee filter
- 1 Filter Base, cut from Engineering Activity 6 Water Reuse Plan Location and Filter Base Cards, pgs. 93-94
- 1 flashlight
- 1 foil tray, 12" × 12"
- 1 measuring cup, 1 cup
- 1 packet of pH strips
- 1 piece of construction paper (the same color for all groups)
- 1 plastic cup
- 1 water sample from Activity 3
- sticky notes

Activity 4 Materials Preparation (40 min.)

Ahead of Time

1. Review the "In-Use Example" in the *Our Ideas* Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
2. Make 7 Filter Bases using the Preparing Filter Bases Instructions, pg. 62.
3. Make one copy of Engineering Activity 4 Testing Materials for Cleaning Handout, pgs. 63-64, for each group.

In Your Space

4. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.
5. Arrange materials on a Materials Table so learners can easily access them.

Teaching Tip

Lead this activity in a room with a sink for easy setup.

6. Fill the 8 oz. plastic container halfway with water and add 1–2 drops of yellow food coloring.
7. Using the strainer, rinse the charcoal under running water for approximately 1 minute until the water runs clear. **Make sure to do this, or the charcoal will make the water quality worse.** Keep the strainer available for use during clean-up.
8. Create a charcoal filter by putting 2 Tbsp of pre-washed charcoal in a square of cheesecloth and tying it closed with a rubber band.

Activity Guide

Get Ready & Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We calculated the quality of water after it has been used in different ways.)* As necessary, draw learners' attention to the *Our Ideas* poster and the terms *clarity*, *pH*, *texture*, and *water quality*.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

2. Ask: **What is the problem we are trying to solve?** *(We are trying to find ways to help people reuse water in places where water is hard to get.)* Show the *Engineering Activity 2 Extreme Environments* slides to remind learners of the locations.
3. Say: **Today we will investigate different materials that can improve the water quality of our samples so that they can be reused.** Share the Guiding Question or a similar question from the *Our Ideas* poster with learners aloud and in writing (using multiple languages as needed): **How can we improve water quality?**
4. Organize learners into groups of four.

Investigate Filter Materials (25 min.)

5. Give each group a copy of *Engineering Activity 3 How Clean Does It Need to Be? Handout*, pgs. 52–53. While pointing to terms on the *Our Ideas* poster, remind learners: **This page explains the water quality that is needed for different uses. Your goal is to find ways to improve water quality by removing contaminants.** Note that there is a difference between somewhat contaminated water, which can be used again for several different purposes, and very contaminated water, which cannot be reused except to water plants no one is going to eat.
6. Say: **You will work in groups to test how well each material removes contaminants from one of the water samples.** Give each group a copy of *Engineering Activity 4 Testing Materials for Cleaning Handout*, pgs. 63-64, to review the testing instructions.

Teaching Tip

The use of "very contaminated water" has been simplified for this activity. In practice, whether very contaminated water can be reused depends on the type of contamination and how it is used. Water that has a very high or very low pH, for example, may be suitable for some plants but not others. Water with contaminants that should be kept out of soil and groundwater (for example, pesticides, motor oil) should not be reused even on landscaping plants.

Level Up!

Show the video The Water Cycle to explore how water is purified naturally as it moves between states of matter. (5 min.)

7. Ask while pointing to the terms for *contaminants*, *clarity*, *color*, and *pH* on the *Our Ideas* poster, ask: **Does everyone remember what contaminants are?** If needed, return to these terms and have learners discuss the terms and make drawings for them.

8. Make sure learners understand how they will test each filter material. Demonstrate with one filter base, a piece of cheesecloth, a rubber band, the yellow water you prepared, and a foil tray.
   - First, you will record the water quality (clarity, color, pH, smell, texture) of your sample in the "Before Filtering" section on *Cleaning Results*, pgs. 9-10 in their *Engineering Notebook*. (Remind the group that they have information about the water quality of their sample from the previous activity, and they can share it with teammates who were not present.)
   - Then, you will place a material on the top of the base. (Note that before placing any loose materials such as sand or limestone into the base, learners should first put down a piece of cheesecloth as a liner.) Demonstrate by attaching a piece of cheesecloth above the filter base with a rubber band.
   - You will pour 1/2 cup of your water sample over the material. Demonstrate by pouring yellow water over the cheesecloth.
   - You will measure and record the water quality of the sample in the base in the column for the material you used.
   - You will place used materials into the foil trays. Demonstrate by putting the cheesecloth and rubber band in a foil tray. Return the yellow water to its original container.

9. Give each group its water sample from Activity 3.

10. Invite groups up to the Materials Table to collect one base, a foil tray, and their materials. Encourage learners to examine the different materials they will be investigating (cheesecloth, cotton balls, limestone, paper towels, and sand) with sight and feeling before testing.

11. Remind learners that they will test each material separately, so they should pour only 1/2 cup of the polluted water sample through the material for each test.

12. As learners are working, ask: **How is this material affecting the quality of the water? Does it improve the clarity, color, pH, smell, or texture? Which material removes contaminants best?** Have learners fill out *Cleaning Results*, pgs. 9-10 in their *Engineering Notebook*.

Support Learner Differences

As needed, provide groups with a tub or other container to hold their materials.

Teaching Tips

- Learners can use rubber bands to secure filter materials in the base.
- Have learners use plastic cups to save cleaned water samples for comparison to the original. It helps to look at these samples against white paper.
- Between smell tests, learners may need to smell something cleansing, such as peppermint, in order to notice if the smell is different.

13. Write the names of the filter materials on the *Our Ideas* poster. After learners are finished testing, say: **Now we will gather information as a group about the materials we tested. You will write the type of sample or contaminants you had on sticky notes, then you will put the sticky notes on the *Our Ideas* poster next to the names of the material that removed contaminants the best.** Give learners several minutes to do this. Have learners examine the results and talk in their groups about what patterns they notice.

14. After learners are finished testing, ask: **How would you describe what the materials you tested are doing to the water?** *(Cleaning, treating, purifying, filtering.)* Say: **One word engineers use for materials like these is *filter*.** Have learners come up with a definition for the word *filter* together and record it on the poster. (For example: a technology that removes some kinds of contaminants from water.) You can have learners add translations and related images to the poster as well.

15. Explain that some filters need more time to treat the water. Bring out the plastic container of yellow water and the charcoal filter bag. Let learners know that there is charcoal inside the cheesecloth bag. Place the charcoal filter bag into the yellow water and explain that they will check on this filter at the end of the next activity. Save some of the yellow water in a container with no charcoal, so that you can compare the results in Activity 5.

Reflect (10 min.)

16. Have groups pair up and discuss the Guiding Question on the *Our Ideas* poster: **How can we improve water quality?** *(Different filter materials can remove different types of contaminants from water.)* **Which materials could you combine to improve water quality even more?**

Support Learner Differences

Consider attaching small pieces of each material to the *Our Ideas* poster. You can leave space on the chart for learners to write the names of materials in their preferred languages.

Teaching Tips

Successful filters make the water quality better (high clarity, colorless, neutral pH, no smell, no texture). Different filter materials have different expected results:

- Limestone balances an acidic pH.
- Cheesecloth, cotton balls, paper towel, and sand all remove particles and may slightly improve color.

The charcoal filter may take 24–48 hours to remove color from the water.

Consider having learners populate a Water Quality chart using their data from *Our First Water Sample*, pg. 8 in their Engineering Notebook (PDF) or record this on the *Our Ideas* poster so they can reference it in Activity 5. See Step 3 of Activity 5 Materials Preparation on pgs. 67-70.

17. Say: **Next time, you will use your knowledge of water quality and filtering to think about how contaminated water can be reused multiple times in different locations.**

Level Up!

- Ask this story prompt question: **Can you tell a story about a kind of filter you've used in the past, for water or for something else?** *(Possible responses include stories about water filters, air filters, and filters for photographs.)* Have learners share with a partner (note that the sharing can take forms other than speaking aloud). Consider returning to learners' ideas at the start of the next activity. (20 min.)
- Tell learners, if anyone asks them what they did today, they can tell them "We explored how filters can improve water quality." (5 min.)
- Refer to the *Engineering Design Process* poster. Ask: **What phases of the Engineering Design Process did you use today?** *(We investigated different filter materials.)* (5 min.)

After the Activity

1. Clean up (watch the video Engineering How to Part 1 (2:55–3:35) for details):
   - Discard the remaining used filter materials.
   - Save the yellow water and charcoal filter for use in Activity 5.
   - Save the sample of yellow water with no charcoal for use in Activity 5.
   - Discard the water samples from Activity 3, using the strainer to prevent any contaminants from going down the drain.
   - Wipe out any remaining contaminants from the inside of the Filter Bases and rinse them in the sink.
   - Rinse the limestone with the strainer and set it aside for later.
   - Save the Filter Bases, aluminum trays, clean filter materials, and *Our Ideas* poster for Activity 5.
   - Collect all handouts.
2. Plan for Engineering Activity 5. See Engineering Activity 5 Preparation on pgs. 67-70.
3. Take time to reflect on the following educator prompt. **How did learners describe their results? How did their descriptions connect to vocabulary introduced in the previous activity?**

Water in Extreme Environments Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/7cb5c428

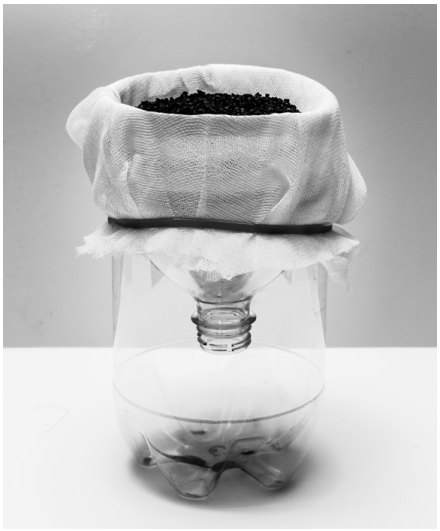
Preparing Filter Bases Instructions

1. Wearing a safety glove, cut a bottle in half with a utility knife.
2. Place painters' tape over cut edges.
3. Remove cap.
4. Save the bottom for catching water.

5. Stack the top of the bottle upside-down inside the bottom of the bottle. This is the Filter Base.

Testing Materials for Cleaning

1. Place material inside the top of the base. (In this example, cheesecloth is used to keep the charcoal from falling through the funnel.)



2. Pour a dirty water sample into the open top of the base.

3. Water flows through the filter material into the bottom of the bottle.

4. Remove the top of the base and place used materials in the foil trays.

5. Measure the quality of the water sample in the bottom of the bottle using 3 to 5 of the same water quality tests as before.

6. Repeat with each material by pouring a new sample of dirty water through each material.