Activity 2 Investigating Filters

Educator Preview

Overview:

Youth *investigate* the ability of various filter materials to remove or treat contaminants from a water sample.

Note to Educator:

Please note the longer prep time for this activity. Lead this activity in a room with a sink for easy clean up. Use caution when cutting plastic bottles. In this activity, the water quality features that youth explore include clarity, color, and pH. The pH strips may stain the tabletop, so have youth place their used strips on a paper towel. **Save the charcoal filter demonstrated in this activity for use in Activity 3. Save any materials that can be reused and the *Investigating Filter Materials* chart for use in Activity 4.**

Activity Timing

Introduction:	5 min
Investigate:	40 min
Reflect:	10 min
	55 min

21st Century Skill Highlight

Critical Thinking

Activity 2 Materials

For the whole group

- ☐ *Engineering Design Process* poster
- ☐ chart paper and markers
- ☐ 1 piece of cheesecloth, 12" x 12"
- ☐ 1 plastic container with lid, 8 oz.
- ☐ 1 roll of paper towels
- ☐ 1 roll of painter's tape
- ☐ 1 rubber band
- ☐ 1 safety glove
- ☐ 1 strainer
- ☐ 1 utility knife
- ☐ 1 vial of food coloring, yellow
- ☐ 2 Tbsp of activated charcoal
- ☐ 8 two-liter bottles

For 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” x 12”
- ☐ 20 rubber bands
- ☐ 40 cotton balls
- ☐ optional: 60 plastic cups, 8 oz.

For each group of 3

- ☐ 1 Filter Base, p. 37 in this guide
- ☐ 1 foil tray, 12” x 12”
- ☐ 1 measuring cup, 1 cup
- ☐ 1 packet of pH strips
- ☐ 1 Secchi disk
- ☐ 1 water sample from Activity 1

For each youth

- ☐ Engineering Notebook

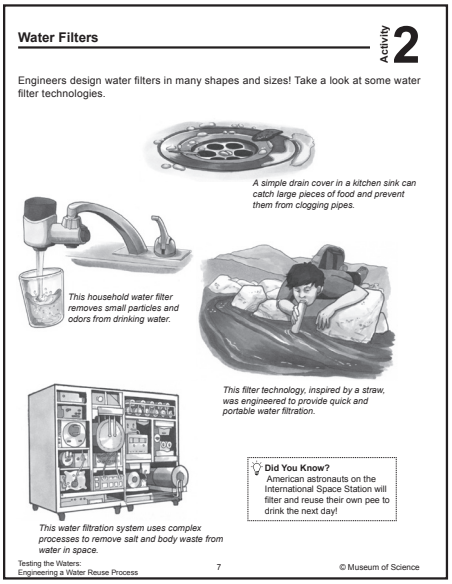
Activity 2 Materials Preparation (40 min)

1. Post the *Engineering Design Process* poster.
2. Make eight Filter Bases using the instructions on *Preparing Filter Bases*, p. 37 in this guide.

3. Create the *Investigating Filter Materials* chart, p. 32 in this guide.
4. Arrange materials on a Materials Table so youth can easily access them.
5. Fill the 8 oz. plastic container halfway with water and add 1-2 drops of yellow food coloring.
6. Using the strainer, rinse the charcoal under running water for approximately 1 minute until the water runs clear.
7. 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.

Notebook Pages for Activity 2

Water Filters, p. 7



Water Filters

Activity 2

Engineers design water filters in many shapes and sizes! Take a look at some water filter technologies.

A simple drain cover in a kitchen sink can catch large pieces of food and prevent them from clogging pipes.

This household water filter removes small particles and odors from drinking water.

This filter technology, inspired by a straw, was engineered to provide quick and portable water filtration.

This water filtration system uses complex processes to remove salt and body waste from water in space.

Did You Know?
American astronauts on the International Space Station will filter and reuse their own pee to drink the next day!

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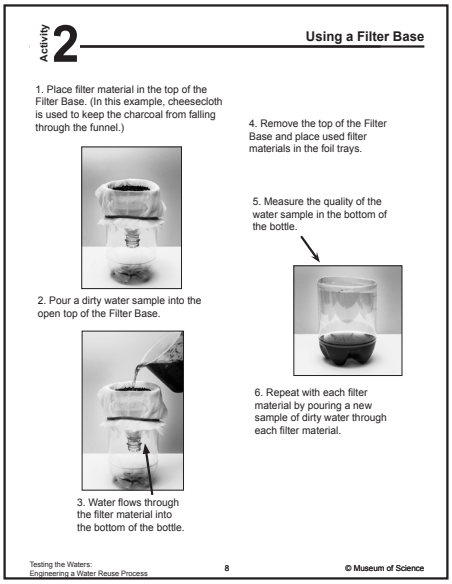
Using a Filter Base, p. 8



Activity 2 Using a Filter Base

1. Place filter material in the top of the Filter 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 Filter Base.

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

4. Remove the top of the Filter Base and place used filter materials in the foil trays.

5. Measure the quality of the water sample in the bottom of the bottle.

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

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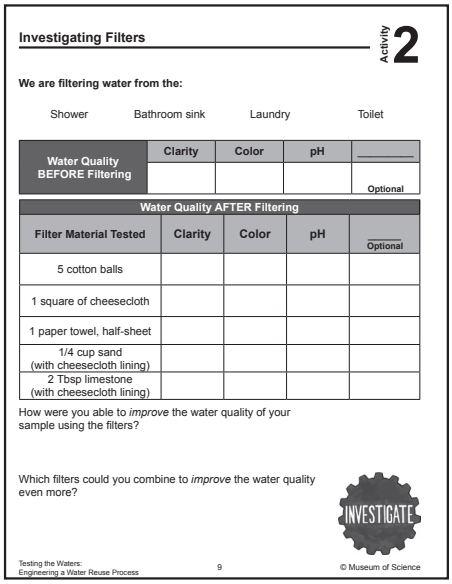
Investigating Filters, p. 9



Investigating Filters

Activity 2

We are filtering water from the:

Shower Bathroom sink Laundry Toilet

Water Quality BEFORE Filtering	Clarity	Color	pH	_____ Optional

Water Quality AFTER Filtering				
Filter Material Tested	Clarity	Color	pH	_____ Optional
5 cotton balls				
1 square of cheesecloth				
1 paper towel, half-sheet				
1/4 cup sand (with cheesecloth lining)				
2 Tbsp limestone (with cheesecloth lining)				

How were you able to *improve* the water quality of your sample using the filters?

Which filters could you combine to *improve* the water quality even more?

INVESTIGATE

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Chart for Activity 2

Investigating Filter Materials

Water Location	Quality Before Filtering*			Which Filter Materials Worked Best?
	Clarity	Color	pH	
Bathroom sink				*Write detailed responses in this column, (e.g., limestone improves the pH, cotton balls improved the clarity, etc.)*
Laundry				
Shower				
Toilet				

* If your group is using a fourth criteria for water quality, add a column accordingly.

Activity 2 Investigating Filters

Activity Guide

Youth will learn:
- Engineers design filters to treat water.
- Different filter materials remove different types of contaminants from water.
- Engineers use the *investigate* step to learn more about ways they can solve their problem.

Tip

Replay the *Special Report* video from 4:05 to 4:15 to remind youth about water filters in the reuse process.

Tip

If groups have a different sample from the last activity, they can re-measure the quality or copy the data from *Water in the Home*, p. 4 in their Engineering Notebooks.

Tip

Since one water sample (e.g., shower) may be tested by more than one group, consider having those groups test half of the filter materials and share their data to save time.

Investigate (5 min)

1. Show youth the model water samples from Activity 1. Have them think back to when they *investigated* water quality by asking:
   - **What is the problem we are trying to solve?** *We need to reuse water instead of wasting it, so we need to engineer a process for reusing water.*
   - **Why can't we reuse any of these water samples?** *Because all of the water was waste water, which cannot be reused.*
2. Tell youth that today they will *investigate* different filters to *improve* the water quality of their samples so that they can be reused.
3. Have youth turn to *Water Filters*, p. 7 in their Engineering Notebooks, and read about some filter technologies used to treat water. Some of these technologies may be new to youth, and some they may be familiar with already.

Investigate Filter Materials (40 min)

1. Show youth the different filter materials they will be investigating today (cheesecloth, cotton balls, limestone, paper towels, and sand).
2. Explain that they will work in groups to test how well each material removes contaminants from one of the water samples. Assure groups that they will eventually get to combine multiple filters, but for now they will test each filter separately. Ask:
   - **Why do you think it might be useful to test each filter separately for now?** *If we test each filter by itself, we can see how much it might impact our final designs.*
3. Have youth turn to *Using a Filter Base*, p. 8 in their Engineering Notebooks, to review the testing instructions. Make sure youth understand they will:
   - First, record the water quality (clarity, color, and pH) of their sample in the "Before Filtering" section on

Tip

Have youth use the plastic cups to save their cleaned water samples for comparison to the original.

Tip

Youth can use the rubber bands to secure filter materials in the filter base.

Tip

Youth can manipulate the filter materials by folding and layering them. Encourage them to be creative!

Tip

Successful filters make the water quality better (neutral pH, high clarity, and colorless).

Tip

Different filter materials have different expected results:

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

Investigating Filters, p. 9 in their Engineering Notebooks.

- Place a filter material in the top of the Filter Base and pour 1/2 cup of their water sample over the filter. (Note that before placing any loose materials; e.g., sand, limestone; into the base, youth should first put down a piece of cheesecloth as a liner.)
- Measure and record the water quality of the sample in the base.
- Place used filter materials into the foil trays, and repeat this procedure for all the filter materials.

4. Split youth into groups of 3. Distribute one water sample from Activity 1 to each group. Be sure water from each location gets tested.
5. Invite groups up to the Materials Table to collect one Filter Base, a foil tray, and their filter materials.
6. Remind youth that they will test each filter material separately, so they should only pour 1/2 cup of the polluted water sample into the water filter for each test.
7. As youth are working, ask:
   - **How is this filter material affecting the quality of the water? Does it improve the pH, the color, and/or the clarity?**
   - **Is one filter material working better than the others to clean your water sample?**
8. Once groups have tested all of the filter materials, call groups back together and have them share out which filter was most successful at treating their water sample.
9. Record the whole group's data on the *Investigating Filter Materials* chart. For the "Which Filter Materials Worked Best?" column, add detailed notes about which materials worked best for treating different features (clarity, color, pH, etc.). Ask:
   - **What worked well with the filter materials? What problems did you notice with the filter materials?** *Accept all answers.*
   - **Was anyone able to remove the color from the water in their samples?** *Most groups will have some residual color left in their samples, particularly the yellow food coloring.*

Reflect (10 min)

1. 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 youth know that there is charcoal inside the cheesecloth bag. Place the charcoal filter into the yellow water and explain that they will check on this filter at the end of the next activity. Consider taking a picture of the

sample so that you can compare the results in Activity 3.

2. Congratulate youth on their engineering work so far. Ask:
   - **Which steps of the Engineering Design Process did we use today?** *We* investigated *different filter materials.*
   - **How do filters help us solve our problem of being able to reuse water?** *Now we can treat the waste water so that it is clean enough to be reused.*
3. Tell youth that in the next activity, they will use their knowledge of water quality and filtering to reorder the pipes in a home so that water can be reused.
4. Have youth clean up by rinsing the limestone with the strainer and setting it aside for use in later activities. Discard the remaining used filter materials.
5. Discard the water samples that youth created in Activity 1, using the strainer to prevent any contaminants from going down the drain.
6. Wipe out any remaining contaminants from the inside of the Filter Bases and rinse them in the sink.
7. Save the *Investigating Filter Materials* chart for the next activity. Save the Filter Bases, aluminum trays, and clean filter materials for Activity 3.

Sustainability Tip

Just as youth are learning about water reuse, you can reuse some of the materials in later activities. Rinse and set aside the limestone, charcoal, filter bases, and aluminum trays to be reused.

Preparing Filter Bases:

1. Using a safety glove, cut bottle in half with a utility knife.

2. Place painters tape over cut edges.

3. Remove cap.

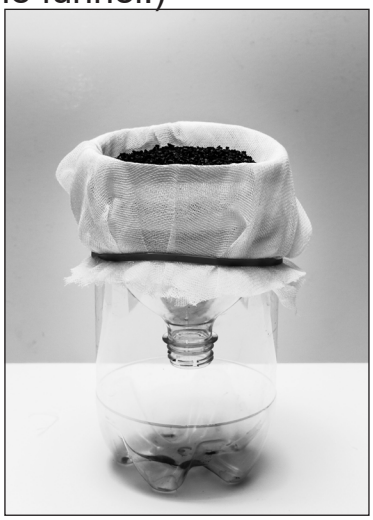
4. Save bottom for catching water.

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

Filter Base

Using a Filter Base:

1. Place filter material in the top of the Filter Base. (In this example, cheesecloth is used to keep the charcoal from falling through the funnel.)



2. Pour dirty water sample into open top of the Filter Base.

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

4. Remove top of the Filter Base and place used filter materials in the foil trays.

5. Measure the quality of the water sample in the bottom on the bottle.

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