Activity 1 A Grey Area

Educator Preview

Overview

Youth *investigate* how using water for various tasks can impact the water's quality.

Note to Educator:

During this activity, groups will create a model water sample and test the water quality using real tools. Lead this activity in a room with a sink for easy setup. Use towels or paper towels to clean up any spills. The pH strips may stain the tabletop, so have youth place their used strips on a paper towel. **If you have less than 8 groups, be sure to create a sample from each location. Save the water samples for use in Activity 3.**

Activity Timing

Introduction:	5 min
Modeling:	20 min
Water Quality:	25 min
Reflect:	10 min
	60 min

21st Century Skill Highlight

Critical Thinking

Activity 1 Materials

For the whole group

- ☐ *Engineering Design Process* poster
- ☐ 1 permanent marker
- ☐ 1 roll of masking tape
- ☐ 1 roll of paper towels
- ☐ 2 pairs of scissors
- ☐ 4 tablespoons
- ☐ 4 teaspoons
- ☐ 4 rulers
- ☐ 5 sheets of cardstock

For the Materials Table

- ☐ 1 bottle of soap
- ☐ 1 bottle of white vinegar
- ☐ 1 spool of thread
- ☐ 1 Tbsp of detergent
- ☐ 1 tube of toothpaste, travel size
- ☐ 1 vial of food coloring, yellow
- ☐ 2 sticks modeling clay
- ☐ 4 Tbsp of soil
- ☐ 4 tea bags, black tea

For each group of 3

- ☐ 1 craft stick
- ☐ 1 jar, 1/2 gallon, filled with water
- ☐ 1 packet of pH strips
- ☐ 1 Secchi disk
- ☐ 1 *Water Sample Recipe*

For each youth

- ☐ Engineering Notebook

Activity 1 Materials Preparation (15 min)

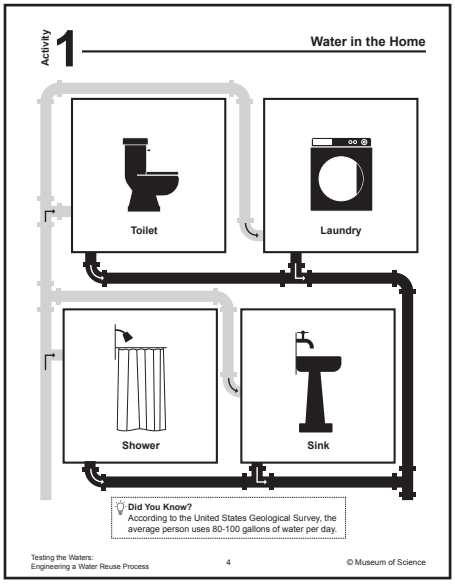
1. Post the *Engineering Design Process* poster.
2. Make two copies of *Water Sample Recipes*, p. 23 in this guide. Cut out each recipe, and distribute one to each group.
3. Make copies of *Secchi Disk* onto the cardstock, p. 27 in this guide. Cut out the Secchi disks, one for each group, and save the rest

in case they get wet. Consider laminating these so they are water resistant.

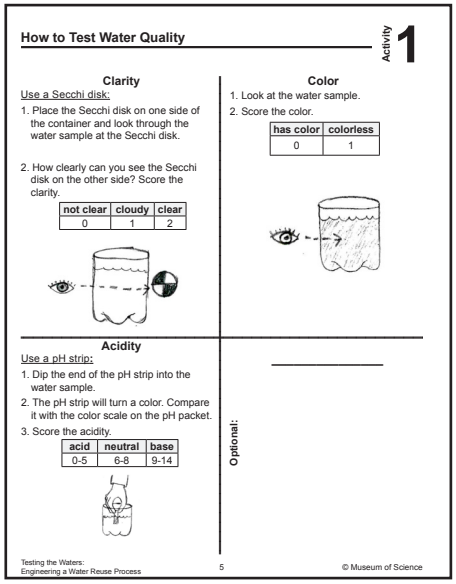
4. Review instructions on *How to Test Water Quality*, p. 25 in this guide; p. 5 in the Engineering Notebook.
5. Arrange the materials (model contaminants) listed above on the Materials Table for youth to access throughout the activity. Place the teaspoons, tablespoons, and scissors on the Materials Table for youth to share.
6. Optional: Make copies of the *Acidity Chart*, p. 29 in this guide. Allow groups to compare the acidity of their water samples with the common contaminants on the chart.

Notebook Pages for Activity 1

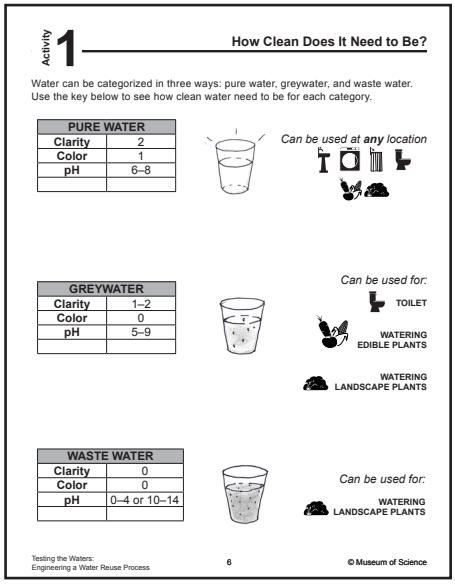
Water in the Home, p. 4



How to Test Water Quality, p. 5



How Clean Does It Need To Be?, p. 6



Activity 1 A Grey Area

Activity Guide

Youth will learn:

- Engineers use models to *investigate* the problem they are trying to solve.
- Engineers and scientists measure water quality to find out how safe the water is to use for certain tasks.
- They can use tools to evaluate water quality.

Tip

Replay the *Special Report* video from 0:50 to 1:42 to review the problem of water scarcity in extreme environments.

Tip

On *Water in the Home*, p. 4, have students use their fingers to trace the white pipes that show pure water going in, then the black pipes that show waste water going out.

Tip

While drinking water and cooking water will not be modeled in this unit, discuss with youth that these are essential tasks that must also be considered in water-scarce environments.

Introduction (5 min)

1. Have youth think back to the *Special Report* video they watched in the last activity and help them remember their challenge over the next few days. Ask:
   - **What problem are we working to solve?** *We need to design a process to reuse water in a water-scarce environment.*
2. Let youth know that before they think about ways to reuse water, they will *investigate* how people typically use water in their homes. Ask:
   - **When do you use water in your home?** *Drinking, cooking, washing dishes, showering, washing hands, etc.*
3. Have youth turn to *Water in the Home*, p. 4 in their Engineering Notebooks. Explain that they will focus on the water used in four locations: the Bathroom Sink, Laundry, Shower, and Toilet.
4. Show youth how the piping in the house starts at “pure water in”, travels to each location in the home, and ends as “waste water out” after it has been used.
5. Ask:
   - **What everyday tasks use water from these locations?** *Hand washing, teeth brushing, body washing, etc.*
   - **What might you find in the water after it has been used?** *Soap, dirt, urine, etc.*
6. Explain that things that make water dirty are called contaminants.
7. Explain that engineers often develop and use models to *investigate* the problems they are working to solve. Today, they will work together to create models of contaminated water at four locations in the home.

Modeling Contaminated Water (20 min)

1. Split youth into groups of 3 and distribute one Water Sample Recipe to each group, with two groups assigned to each recipe.

2. Show groups the Materials Table with the model contaminants. Give groups 10–15 minutes to create their water samples.
3. As groups are working, encourage them to record their model contaminants on *Water in the Home* p. 4 in their Engineering Notebooks.
4. Ask:
   - **What real contaminants do you think these materials represent?**
   - **Are you surprised by any of the model contaminants?**
5. After youth make their models, have them share their contaminated water samples with the entire group. Ask:
   - **What do you notice about your models? What is similar? What is different?** *Our sample is cloudy, this sample is brown, all samples have particles floating in them.*
   - **If you had to choose, which of these water samples would you use again?** *Accept all answers.*
   - **How can we tell if the water is safe enough to reuse?** *Accept all answers.*
6. Explain that the term "water quality" refers to the characteristics that let us know if water is safe to use for tasks like washing hands, taking a shower, swimming, or drinking.
7. Let youth know that for the rest of today, they will measure the quality of their own water sample using the same tools that scientists and engineers use to test water quality.

Tip

The word Secchi is pronounced *SEK-ee.*

Water Quality (25 min)

1. Tell youth that they will measure two features of the water they can see: clarity, or how clear the water is, and color.
2. Hold up a Secchi disk. Explain that this is a tool scientists and engineers use to measure water clarity. Choose one of the water samples and model how to use the Secchi disk, following the directions on *How to Test Water Quality*, p. 23 in this guide.
3. Explain that the second feature they can use to measure water quality is the color. Using the water samples, model how to record whether the water has color or is colorless, following the directions on *How to Test Water Quality*, p. 23 in this guide.
4. Explain that there are also ways that contaminants affect the water that we cannot see. Acidity is one way water is affected. If water is too acidic or too basic, it can be harmful to our health.
5. Hold up a packet of pH strips. Explain to youth that pH strips

Tip

Have a volunteer demonstrate how to use the Secchi disk and the pH strips using *Testing Water Quality*, p. 6 in their Engineering Notebook.

Tip

Remind youth that colorless and clear do not mean the same thing. Give an example, like apple juice, that is clear but has a yellow color.

are a tool used to measure how acidic or basic the water sample is. Choose one of the water samples and model how to use a pH strip, following the directions on *How to Test Water Quality*, p. 23 in this guide.

6. Have youth return to their groups and measure the quality of their own water sample. They should refer to *How to Test Water Quality* on p. 5 in their Engineering Notebooks.
7. Have youth record this information on *Water in the Home*, p. 4 in their Engineering Notebooks.
8. Have groups share out about the quality of their water samples. Encourage youth to record the quality of the other samples in their Engineering Notebooks.

Reflect (10 min)

1. Gather youth together and ask:
   - **What are the three categories of water introduced in the Special Report Video?** *Pure water, greywater, and waste water.*
2. Tell youth they will determine which category their model samples fall into. Have youth turn to *How Clean Does It Need To Be?*, p. 6 in their Engineering Notebooks, to look at the criteria for each category.
3. Ask:
   - **How did you categorize your water sample?** *Waste water.*
   - **Why is it important to measure water quality?** *So we know if the water is safe to use.*
   - **What can we do to make this water reusable?** *We can clean it.*
4. Let youth know that next time, they will use what they learned about water quality to reconfigure the pipes in a home so that the water can be reused.
5. Gather youth in front of the *Engineering Design Process* poster. Ask:
   - **What steps of the Engineering Design Process did you use today?** *We* investigated *how water is used in the home and how water quality is measured.*
6. Using the permanent marker and masking tape, have youth label the water samples they made (Bathroom Sink, Laundry, Shower, or Toilet) and save them for use in the next activity.

Tip

Optional: Pass out the *Acidity Chart*, p. 29 in this guide, to see a chart that displays common water contaminants and their acidity levels.

Tip

Optional: Have the entire group decide on one additional measurable feature to determine water quality. Have youth complete the quality chart and fill in the testing directions on *How to Test Water Quality*, p. 5 in their Engineering Notebooks.

Tip

If youth are having difficulty remembering the three types of water, have them refer to the *Glossary*, p. 24 in their Engineering Notebooks. Alternatively, create a *Types of Water* chart with the three definitions and hang it up for each activity.

Activity 1

Water Sample Recipes

Bathroom Sink Water Sample

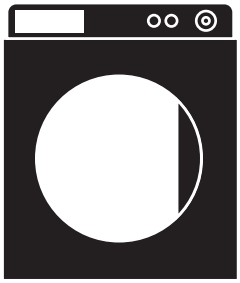
- ☐ 1/2 gallon jar of water
- ☐ 1 tsp soap
- ☐ 2 pea-sized blobs of toothpaste

Add everything to the jar and stir well.

Laundry Water Sample

- ☐ 1/2 gallon jar of water
- ☐ 1 tsp tea leaves
- ☐ 1 Tbsp detergent
- ☐ 2 tsp soil

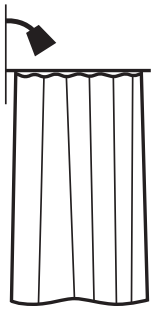
Add everything to the jar and stir well.



Shower Water Sample

- ☐ 1/2 gallon jar of water
- ☐ 1 tsp soap
- ☐ 1 tsp soil
- ☐ 2 Tbsp vinegar
- ☐ 30 pieces of thread approx. 3-5” long

Add everything to the jar and stir well.



Toilet Water Sample

- ☐ 1/2 gallon jar of water
- ☐ 1 tsp soap
- ☐ 1 tsp tea leaves
- ☐ 1 Tbsp soil
- ☐ 2 drops yellow food coloring
- ☐ 2 logs of modeling clay, approx. 2-3” long

Add everything to the jar and stir well.

Activity 1

How to Test Water Quality

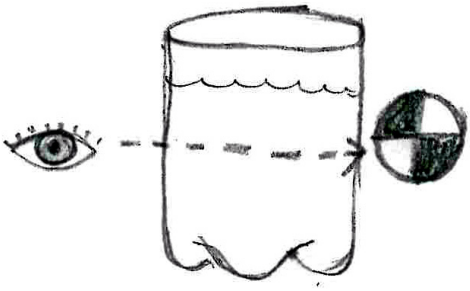
Clarity

Use a Secchi disk:

1. Place the Secchi disk on one side of the container and look through the water sample at the Secchi disk.

2. How clearly can you see the Secchi disk on the other side? Score the clarity.

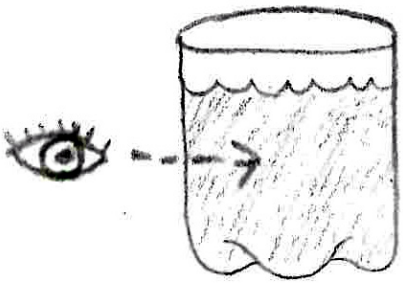
not clear	cloudy	clear
0	1	2



Color

1. Look at the water sample.
2. Score the color.

has color	colorless
0	1

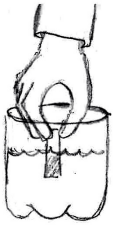


Acidity

Use a pH strip:

1. Dip the end of the pH strip into the water sample.
2. The pH strip will turn a color. Compare it with the color scale on the pH packet.
3. Score the acidity.

acid	neutral	base
0-5	6-8	9-14

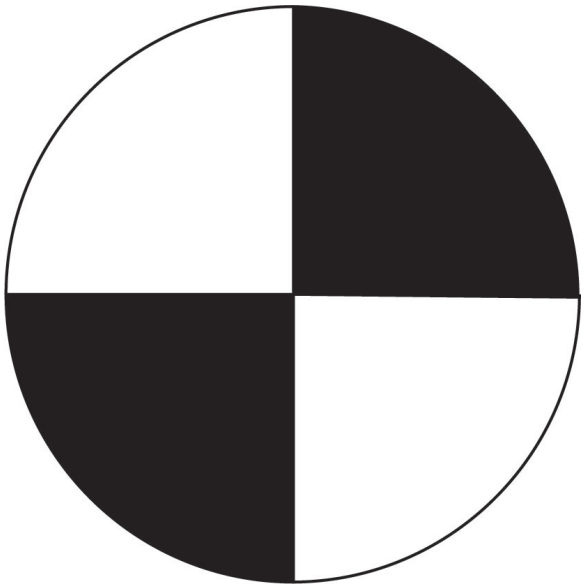


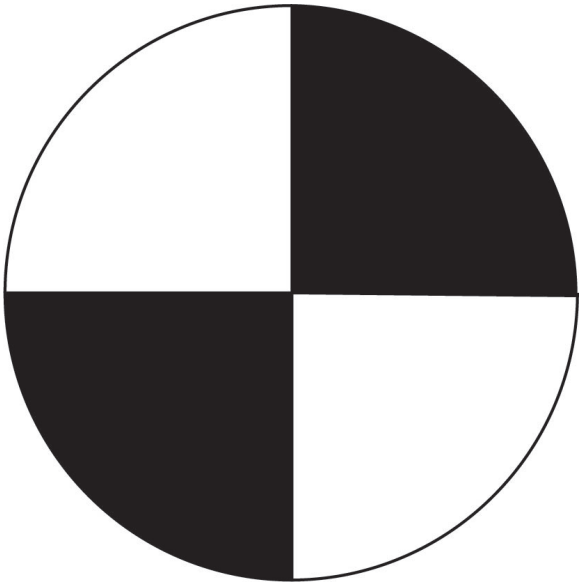
Optional

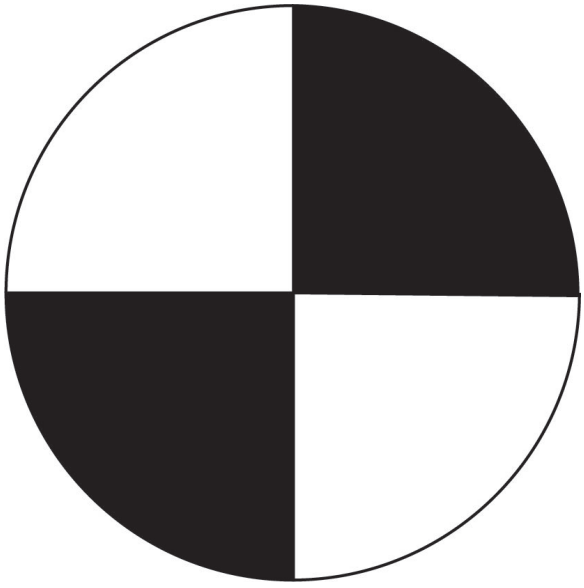
1. Have youth come to a consensus on a fourth feature to evaluate water quality (*e.g., number of particles in the water, size of particles in the water*).
2. Have the entire group decide how to measure this feature and have youth record the group's decision on *How to Test Water Quality*, p. 5 in their Engineering Notebooks.

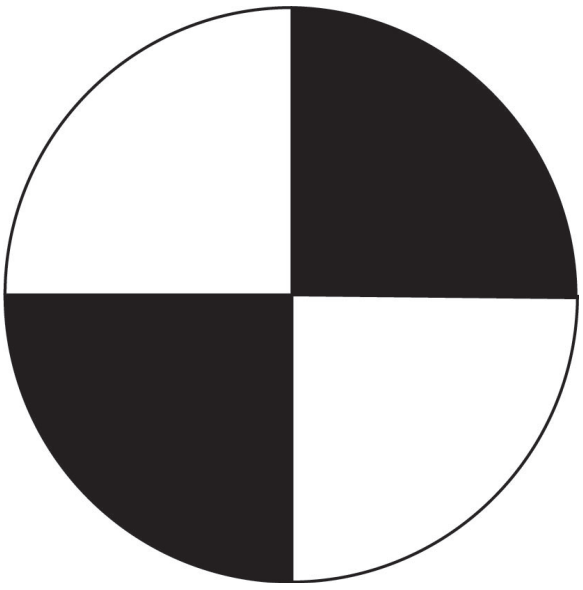
Activity 1 Secchi Disk

Photocopy this page onto cardstock, making one copy for every four groups. Cut out the Secchi disks and give one disk to each group. Keep extra copies in case the disks get wet.









Activity 1

Acidity Chart