



SCIENCE
for Makerspaces



FILTER FUN!

Filter Fun is tied to our Smithsonian Science for Makerspaces, and this lesson plan booklet is geared for and written to guide teachers and students in using this education tool provided by the Smithsonian Science Education Center.



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FILTER FUN!

Next Generation Science Standards

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered, to identify aspects of a model or prototype that can be improved.

Introduction

Student teams will be introduced to the phenomenon of how communities can use materials to filter out pollution in water. They will observe how filtration is a common process that happens in laboratories and in nature. At the end of this challenge students will be able to assess materials for their ability to filter out debris. Students will also devise and test a filter system based on an iterative design process, using 3D printed models and classroom materials.

Observe It!

Teacher will share the following passage with students

Clean water is a very important resource for all of us. However, human activities can cause water sources to become dirty and polluted. Have you seen polluted water? What might happen if someone drank that water? Sometimes water can be polluted with unhealthy minerals, bacteria, and chemicals that can make people sick. To prevent people from getting sick, your community has water treatment centers to make drinking water safe. Water treatment centers take water from the environment and clean it with filters and chemicals. Some people get their water from wells, dug deep into the ground. How can that water be clean and safe to drink? Natural materials like sand, rocks, and plants also help to clean water. Some places, like wetlands and marshes, are especially important in this process.



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Make It!

Safety

Remind students that every substance in science class should be treated as a chemical, even if it is a common food or liquid. Even though the water in this exercise may look clear it is not safe to drink.

Makerspace Technology and Materials

- 3D printer with filament
- 3D printer design software
- USB drive

Teacher will print off the Smithsonian Filter Kit for each student group

Link to the Filter Kit model can be found on the resource website.

Smithsonian Filter Kit model dimensions: 3 x 3 x 5 inches

Steps to Print

1. Download the Smithsonian Filter Kit STL file.
2. Open your 3D printer design software.
3. Start a new project and Import the Smithsonian Filter Kit Model.
Optional: Scale and Rotate the models as needed.
Optional: Apply printing supports as needed.
4. Export and Open the project on your 3D printer. This may require a USB drive if your printer is not hooked up to your computer.
5. Print the models.

Approximate about **7 hours** of printing time for each kit.

Smithsonian Connections

To learn more on how communities use water as a resource, visit Waterways from Museum on Main Street <https://museumonmainstreet.org/content/waterways>

Additional Materials for Each Student Group

- 1 4-ounce cup
- 1 large container filled with water mixed with coffee grounds and potting soil
- 1 medium container half full of water
- Newspaper, to use as padding for spills
- 1 materials pack for each group containing
 - 1 4-ounce cup of grass blades
 - 1 4-ounce cup of sand
 - 1 4-ounce cup of small rocks or gravel
 - 1 coffee filter, cut to fit the size of a filter tray
 - Cotton balls, stretched to fit the size of a filter tray



Design It!

Students will assess a material for its ability to filter out debris

Teacher will give each student a Filter Fun worksheet

The Design It! stage is separated into two sections. In Part 1, students will test four filter materials. Students will add a material to a filter tray. Student groups will fill up their empty 4-ounce cup with dirty water and pour it through one filter tray. Students will look at the drip pan at the bottom of the filter and assess the filtered water for clarity. In Part 2, students will design a filter system, choosing three materials and determining the order of the materials for their filter.

Design It! Part 1

- Students will test up to three filter materials in their filter trays. Students will need to swap out one of their filter tray materials to test all four.
- Students will pour dirty water from a cup through each material.
- Students will record whether the material is natural or artificial and rank the

results based on the water's clarity, on a scale of 1 to 5 (where 1 is very clear and 5 is very dirty).

- Students will rinse the material in a wash pan or large bowl filled with water.

Design It! Part 2

- Students will plan out the order of materials in their filter system.
- Teacher will ask, "What materials might be better for the top of the filter? What materials might be better for the bottom of the filter? Why?"
- Students groups will discuss the strengths and weaknesses of each model.

Test It!

Students groups will devise and test a filter system based on prior observations

The Test It! stage is separated into two sections. In Part 1, student groups will pour dirty water through the filter system. They will score the clarity of the resulting water. They will rearrange their materials and pour a second cup of dirty water through the filter. Student groups will score the clarity of their second attempt. In Part 2, students will make observations and compare and contrast the two systems.

Test It! Part 1

- Student groups will have decided on one filter system and will order the three filter trays with unique materials.
- Student groups will pour a cup of dirty water through the filter system and will assess the resulting water for clarity on a scale of 1 to 5.
- Student groups will wash off the materials in the wash pan or bowl.
- Student groups will rearrange the model and pour another cup of dirty water through the filter system. They will assess the resulting water for clarity on the same scale.

Test It! Part 2

- Students will rank the strengths and weakness of each of their two systems.
- Teacher will ask, "Which model would you recommend to the community. Why?"
- Teacher will ask, "Even though the water is clear, it is still not safe to drink. Why do you think that is?"

Assessment Questions

What materials were best by themselves?

What was the best natural material? What was the best artificial material?

Why do water filters use many materials instead of just one?

What filter materials worked best in combination?