 

**ELEMENTARY SCHOOL**

**Sustainable Science**

**Desalination Design Challenge**

**Lesson 4: Fresh Filters: Get the Mud Out**

**Teacher Background and Overview:**

When engineers design a solution to a problem, they must repeatedly test prototypes and evaluate their results to see how they can make their designs better. At the same time, they must consider the scalability of their product and how expensive it will be to make and distribute. Often, more than one design may help solve the same problem. Green chemistry criteria can help scientists and engineers decide which design will be the most effective. Ultimately, the best solution will most likely be the one that is sustainable and safe for human health and the environment, is the most cost effective, and works just as well or better than the other available options.

In this lesson, students will build the filters they designed in Lesson 3. They will then test how well their prototype removes mud and salt from water, and use their results to propose and make one change to improve their filter design.

**Additional Resources:**

*Chemistry for Kids: Separating Mixtures* <http://www.ducksters.com/science/chemistry/separating_mixtures.php>

**Time Required:**

45 minutes

**Learning Objectives:** Students will…

* Determine how filtration systems separate some mixtures.
* Evaluate the effectiveness of their water filter.
* Revise and improve their prototype design.

**Standards:**

***NGSS***

**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.

**5-PS-1** Develop a model to describe that matter is made of particles too small to be seen.

***Massachusetts Standards***

*STE*

**5-ESS3-2(MA)** Test a simple system designed to filter particulates out of water and propose one change to the design to improve it.

**5-PS1-1** Use a particle model of matter to explain common phenomena involving gases, and phase changes between gas and liquid and between liquid and solid.

*ELA & Literacy*

**WS.5.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

**SL.5.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly.

**Materials:**

* 3 L water
* 900 g salt
* 3 L muddy water (dirt mixed with water)
* Copies of student filter designs from Lesson 3

Suggested:

* Paper towels
* Screen
* Coffee filters
* Gravel (small stones)
* Sand
* Cotton balls
* Small, clear plastic cups (~5 per group)
* Used plastic drink bottles
* Popsicle sticks for stirring
* Medium-sized funnels
* Hydrometer
* Graduated cylinder or measuring cup
* Waste container (if sink is unavailable in classroom)

**Teacher Preparation:**

* Prepare muddy water mixture.
* Make materials accessible for students’ filters.

**Keys to Success:**

* Materials for this lab may vary. You are encouraged to use materials that are readily available in your school.
* You may wish to give students a time limit for completing the construction of their filters. You will want to give prompts to help the class stay on track.
* You may wish to save time by preparing the saltwater mixture prior to class, if your students do not need practice measuring materials.
* You may wish to pre-measure 100-ml portions of muddy water mixture and saltwater solution ahead of time.
* Examples of potential filter options are presented at the end of this lesson.

**Extension Options:**

* This lesson can be extended by having students propose and make a second design change in their filters, and testing their results a third time.

**Procedure:**

1. Remind students that they will be building the filters they designed in Lesson 2, and that each filter will be evaluated using both a muddy water mixture and a saltwater solution.
2. Have student groups pull out their filter designs from Lesson 3.
3. Discuss as a class how they will measure the effectiveness of their filters for both muddy water and salt water. *Remind students that taste testing is not an option for saltwater*.
4. Hand out and briefly review the Student Lab Reports. Instruct students to fill out their predictions on their Student Lab Report.
5. Allow students to make their filters, periodically reminding them to stay on track for the allotted time you have given them.
6. When filters are ready for testing, pass out 100 ml of muddy water to each pair and guide students in measuring 100 ml of water and 30 g of salt for their saltwater solution.
7. Provide students with a hydrometer to test the filtered water for salt.
8. Have students record their observations and data in their Student Lab Report.
9. Instruct students to follow the Student Lab Report in evaluating their filter and proposing a change to their original design.
10. Have students repeat the constructing and testing steps for their modified filters.
11. When students finish testing their filters, have them clean up their workstations.

**Wrap-Up/Assessment:**

1. Have partners work together to complete the Discussion and Conclusion sections of their Student Lab Reports.

**Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

***Fresh Filters: Get the Mud Out: Lesson 4 Student Lab Report***

In this lab, you will build and evaluate the filter you designed in Lesson 3, using a muddy water mixture and a saltwater solution. You will be visually assessing your muddy water mixture and using a hydrometer to measure the salt content left in your saltwater solution after filtration. Once you have collected and considered your data from your experiment, you will make one modification to improve your filter’s performance.

**Predictions:**

What do you predict will happen when you pour the muddy water mixture through your filter?

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What do you predict will happen when you pour the saltwater solution through your filter?

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**Observations and Data:**

List all of the materials used in constructing your filter. For each trial, record the properties of the mixture or solution both **before** and **after** filtration.

|  |  |  |
| --- | --- | --- |
| Materials used in filtration trials | Trial #1A: Muddy water | Trial #2A: Salt water |
|  | **Before:** | **Before:** |
| **After:** | **After:** |

Propose one change you plan to make to your filter that will improve its effectiveness. What do you think will happen as a result of this modification?

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List any changes in the materials you used to build your modified filter. For each trial, record the properties of the mixture or solution both **before** and **after** filtration.

|  |  |  |
| --- | --- | --- |
| Changes made to the materials used in the filter | Trial #1B: Muddy water | Trial #2B: Salt water |
|  | **Before:** | **Before:** |
| **After:** | **After:** |

**Discussion:**

Did the modification you made to your filter design improve the effectiveness of your filter? Why or why not?

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What are some of the problems you encountered while trying to separate salt from the water?

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Refer back to the articles from Lesson 2. Does your system resemble any of the animals’ techniques for removing salt? Explain why or why not.

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**Conclusion:**

Provide one idea to improve separation of salt from water.

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**Filter Example:**

 