

**ELEMENTARY SCHOOL**

**Sustainable Science**

**Desalination Design Challenge**

**Teacher Background and Overview:**

Desalination is the process of extracting minerals, generally salt, from salt water. This is one of many methods used to provide a supply of fresh water for human consumption and irrigation. Water scarcity is a growing issue in many parts of the world; as the global need for fresh water increases in relation to population growth, climate change, and other factors, the use of desalination techniques will increase. At present, desalination processes are energy inefficient and expensive, making them a difficult technology to scale and adopt in high-need areas.

Green chemistry is the science of designing chemical products and processes to reduce or eliminate the use or generation of hazardous substances. When considering sustainable technology, green chemistry principles and practices provide a strong framework for designing and evaluating products and processes, such as desalination. For a process to be considered a green chemistry technology, it must meet three criteria: safety, performance, and cost. In addition to being better for human health and the environment, the product must also work just as well or better, and cost about the same or less than the existing alternative.

When scientists and engineers look for safe, sustainable solutions to different problems, they often look to nature for inspiration. *Biomimicry* is the art and science of taking inspiration from nature in the design of new technologies. Though human technologies for desalination have proven to be both financially and energy intensive, nature has evolved to deal with salt in numerous different ways to help animals and plants thrive in high-saline environments.

In this unit, students will be introduced to issues surrounding water availability and they’ll use the engineering design process to evaluate both water filtration and desalination as solutions to global challenges. By considering how nature filters out salt, and by using the lens of green chemistry, students will form a fresh perspective on water sustainability and learn how they can use their own creativity to solve real-world problems.

**Additional Resources:**

*Desalination Pros and Cons List*

<https://nyln.org/desalination-pros-and-cons-list>

*Advantages and Disadvantages of Desalination*

<https://www.biotechwater.com/advantages-disadvantages-desalination/>

*Introduction to Global Water Scarcity*

<http://www.eschooltoday.com/global-water-scarcity/global-water-shortage-for-kids.html>

*The Water Cycle for Schools*

<https://water.usgs.gov/edu/watercycle-kids.html>

*Earth’s Water*

<https://pmm.nasa.gov/education/lesson-plans/earths-water>

**Prerequisites:**

* Students should already understand the water cycle (MA STE 5-ESS2-1)
* Students should have been introduced to particle models (MA STE 5-PS1-1)

**Lesson Summaries:**

*Lesson 1*

Time Required: 30 minutes

This lesson invites students to learn about the limited availability of fresh water and introduces them to the unit, in which they will think creatively about desalination: the process that removes salt from saline water. This activity uses containers ranging from an eyedropper to a five-gallon bucket to create a visual model showing how little fresh, drinkable water is available on Earth. Students then reflect on the amount of fresh water humans consume and consider ways to reduce our individual water consumption.

*Lesson 2*

Time Required: 30 minutes (designed for ELA time)

This lesson builds off of Lesson 1 and students’ prior knowledge of water. Through both reading and class discussion, students will learn about adaptations found in nature for conserving water and removing salt from it. Later in the unit, students will use what they learn in Lesson 2 to help them design a water filter and a desalination device.

*Lesson 3*

Time Required: 30 minutes

In this lesson, students will review different types of filters that are used around the world. They will then design a water filter that they’ll build and test with muddy water, using the information on biomimicry and sustainability from Lesson 2. Students will wrap up the lesson by working with their partner to compare sketches and create one final design proposal that uses the best ideas from each partner’s drawing.

*Lesson 4*

Time Required: 45 minutes

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.

*Lesson 5*

Time Required: 30 minutes

In this lesson, students will consider how nature removes salt from water, and then design their own evaporation desalinators. The students will use the engineering design process to craft and test their prototypes throughout Lessons 5 and 6.

*Lesson 6*

Time Required: Multi-day project (2 to 3 45-minute lessons)

In this lesson, students participate in the engineering design process as they construct their desalinators, capture data, and think critically about the effectiveness of their prototype. They will then propose and justify a change to their design that will improve their device.

**Standards:**

***NGSS***

**5-ESS2-2** Describe and graph amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. *Lesson 1*

**5-ESS3-1**Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.*Lesson 3*

**3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. *Lesson 3, Lesson 5*

**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. *Lesson 4, Lesson 5, Lesson 6*

**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.*Lesson 4, Lesson 6*

**5-PS-1** Develop a model to describe that matter is made of particles too small to be seen. *Lesson 4, Lesson 5*

***Massachusetts Standards***

*STE*

**5-ESS3-1** Obtain and combine information about ways communities reduce human impact on the Earth’s resources and environment by changing an agricultural, industrial, or community practice or process. *Lesson 3*

**5-ESS2-2** Describe and graph the relative amounts of salt water in the ocean; fresh water in lakes, rivers, and groundwater; and fresh water frozen in glaciers and polar ice caps to provide evidence about the availability of fresh water in Earth’s biosphere. *Lesson 1*

**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.  *Lesson 4, Lesson 5*

**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. *Lesson 3, Lesson 4, Lesson 6*

**5.3-5-ETS3-1(MA)** Use informational text to provide examples of improvements to existing technologies (innovations) and the development of new technologies (inventions). Recognize that technology is any modification of the natural or designed world done to fulfill human needs or wants. *Lesson 3*

**5.3-5-ETS3-2(MA)** Use sketches or drawings to show how each part of a product or device relates to other parts in the product or device. *Lesson 5, Lesson 6*

*ELA & Literacy*

**RSIT.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *Lesson 1, Lesson 2*

**RSIT.5.2** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text. *Lesson 2, Lesson 5*

**RSIT.5.3** Explain the relationships or interactions of two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text. *Lesson 2*

**WS.5.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.*Lesson 2, Lesson 4*

**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. *Lesson 1, Lesson 2, Lesson 3, Lesson 4, Lesson 5*, *Lesson 6*

**SL.5.2** Summarize a written text read aloud or information presented indiverse media and formats, including visually, quantitatively, and orally. *Lesson 1, Lesson 2, Lesson 5*

**SL.5.3** Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence. *Lesson 5*

**SL.5.4** Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. *Lesson 6*

**SL.5.5** Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *Lesson 6*