

## Rain Machine (Solar Still)

### Student Objectives

The student:

- will explain a simple way to desalinate water using solar energy
- understands the evaporation and condensation process, and relates it to the water cycle on Earth.

### Key Words:

condensation  
desalinization  
evaporation  
purify  
solar still

### Materials (per group):

- large, deep bowl
- small beakers or plastic cups, at least 2" shorter than sides of bowl or cut to size
- clear plastic food wrap
- tape or rubber band large enough to go around bowl
- small rock or weight
- salt
- Science Journal

### Time:

1 class period

### Background Information

Stills are commonly used to purify liquids. Through the process of distillation, non-volatile impurities can be separated from the liquid. Distillation can be a simple process: heat is first added to a liquid to evaporate it and produce a gas or vapor, then heat is removed from the vapor to condense it back to a liquid.

A solar still uses the greenhouse effect to trap energy from the sun. An in-ground solar still collects water from soil by the processes of evaporation and condensation.

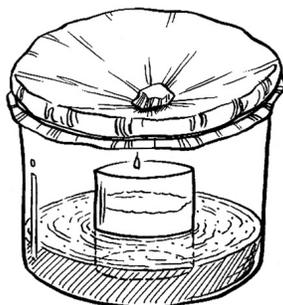
### Procedure (prior to class)

1. Make a solar still as an example for the class.

### Procedure (during class)

1. Lead the class in a discussion of desalination. Questions that might be asked:
  - Have you ever tasted salt water? Can we drink it?
  - What can we do as our supply of fresh water gets smaller, or polluted?
  - If you were lost in a desert without drinking water, and the only water was in a salty pond, how could you survive? (*Evaporation with a solar still*)

- Can evaporation be used on polluted water to make it drinkable? *(Yes)*
2. Divide the class into working groups of 2 – 4 students per group.
  3. Explain the procedure to the class.
    - Put salty water in the bowl.
    - Place the cup in the middle of the bowl.
    - Cover the top of the bowl tightly with plastic wrap and secure with either a rubber band or tape. The bowl must be airtight..
    - Put a weight in the center of the plastic wrap above the cup so that the evaporated water will drip into the cup.



4. Pass out the materials.
5. Help students during the construction process.
6. Place the solar stills in full sun.
7. Write “evaporation” on the board.
8. In their Science Journal, have the students draw their solar still and label the parts.
9. Check the still’s progress as often as you desire, in ½ – 1 hour increments. Point out the small water droplets on the inside of the plastic wrap. Solar stills can be left out overnight (until next class period) if desired.
10. Taste the water in the cup.
11. Lead a discussion of evaporation and desalination. Why does the water taste different than tap water? Advanced students may be interested in finding out what minerals and chemicals are in their tap water.
12. Students should complete their Science Journal page.

### Key Words & Definitions

- **condensation** – a reduction to a denser form as from steam to water
- **desalinization** – process of removing salt and other chemicals and minerals from water
- **evaporation** – process of changing a liquid into vapor
- **purify** – to remove undesirable elements or impurities
- **solar still** – a device that uses solar energy to evaporate a liquid

### Related Research

1. Why is rain always colorless? Try your solar still with colored water or tea. Does the color evaporate and condense into the center container?

2. Research the drawbacks of using a solar still to distill drinking water from sea water on a large (citywide) scale.
3. Can you use a still to remove the water from a solution? Are there solutions from which a solar still would not work to remove water? Research whether bacteria and toxic chemicals are removed during the distillation process.
4. Does the size and shape of the outer (evaporating) container affect its efficiency? Compare containers with different surface areas to see how this affects the evaporation rate. Does the depth (volume) of the liquid in the evaporating container affect its efficiency?
5. Using the knowledge that you have about solar stills, draw plans for a solar still to be used for a family of four after a hurricane (assuming sunny days), that would provide each member of the family with a gallon of drinking water a day.

### **Related Reading**

- ***Real World STEM: Global Access to Clean Water*** by Stuart Kallen (Referencepoint Pr Inc, 2017)  
This book covers the current research being done by scientists and engineers who are developing new techniques for desalination, wastewater recycling, and other technologies meant to guarantee humanity's freshwater needs in the future.
- ***Solar Energy Projects for the Evil Genius*** by Gavin Harper (McGraw-Hill, 2007)  
This book includes more than 50 solar energy projects with plans, diagrams and schematics. Included are three types of solar stills, along with cookers and solar electricity projects.

### **Internet Sites**

**<https://www.swfwmd.state.fl.us/content/water-education-videos>**

Southwest Florida Water Management District videos and teacher guides relating to water quality, watersheds, groundwater and the water cycle.

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

U.S. Geological Survey's Water Science for Schools site includes information on many aspects of water, pictures, data, maps and interactive activities

### Rain Machine (Solar Still)

#### Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
<b>Grade 6</b>														
<b>Practice of Science</b>	# 1	SC.6.N.1				X								
<b>Earth Systems &amp; Patterns</b>	# 7	SC.6.E.7	X											
<b>Grade 7</b>														
<b>Energy Transfer &amp; Transformations</b>	# 11	SC.7.P.11	X	X										

#### Sixth Grade Benchmarks

##### Science–Big Idea 1: The Practice of Science

- SC.6.N.1.4 - Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

##### Science–Big Idea 7: Earth Systems and Patterns

- SC.6.E.7.1 - Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth’s system.

#### Seventh Grade Benchmarks

##### Science–Big Idea 11: Energy Transfer and Transformations

- SC.7.P.11.1 - Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.
- SC.7.P.11.2 - Investigate and describe the transformation of energy from one form to another.

#### National Next Generation Science Standards - Sixth to Eighth Grade Standards

##### Science–Energy

- MS-PS3-4 - Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

##### Science–Earth’s Systems

- MS-ESS2-4 - Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.



5. Describe how this technology could be used in a real world situation.