

## Rain Machine (Solar Still)

### Student Objective

The student:

- will be able to explain a simple way to desalinate water using solar energy
- will understand the evaporation and condensation process, and relate it to the water cycle on Earth.

<b>Key Words:</b> condensation desalinization evaporation purify solar still
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### Materials

- bowl (one per group)
- plastic cups, at least 2" shorter than sides of bowl or cut to size (2 per group)
- clear plastic food wrap
- tape or rubber band large enough to go around bowl (one per group)
- small rock or weight (one per group)
- salty water
- 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.

### **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**

- **Dr. Art's Guide to Planet Earth: For Earthings Ages 12 to 120** by Art Sussman PhD and Emiko Koike, (Chelsea Green Publishing, 2000), pages 28 - 33 "The Water Cycle"  
This book is at once light enough for youth to comprehend and yet comprehensive enough for adults. By breaking the subject down into three primary categories--matter systems, energy systems and life systems, he provides a simple framework for thinking about Earth's systems within systems within systems, and stresses our deep interconnection with them. To keep things in perspective, Art includes a comprehensive discussion of our current environmental issues and the major changes we must institute in order to prevent and mitigate further harm.

### **Internet Sites**

**<http://www.swfwmd.state.fl.us/education/splash/>**

Southwest Florida Water Management District lesson plans relating to water and the water cycle.

**<http://www.swfwmd.state.fl.us/education/kids/>**

Water Resources Education by the Southwest Florida Water Management District includes games, activities, and fact pages.

**<http://ga.water.usgs.gov/edu/>**

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

### **Energy Whiz**

Be an EnergyWhiz star! Submit a student video of your class/group constructing and using your solar still to **<http://energywhiz.com/>**. The best will be posted on the site to be viewed worldwide!

## Rain Machine (Solar Still)

			.1	.2	.3	.4	.5	.6	.7
Nature of Matter	Standard 1	SC.A.1.3-				X			
	Standard 2	SC.A.2.3-			X				
Energy	Standard 1	SC.B.1.3-	X	X	X		X		
	Standard 2	SC.B.2.3-							

**Benchmark SC.A.1.3.4** - The student knows that atoms in solids are close together and do not move around easily; in liquids, atoms tend to move farther apart; in gas, atoms are quite far apart and move around freely.

### Grade Level Expectations

The student:

*Sixth*

- understands that matter may exist as solids, liquids, and gases.

**Benchmark SC.A.2.3.3** - The student knows that radiation, light, and heat are forms of energy used to cook food, treat diseases, and provide energy.

### Grade Level Expectations

The student:

*Sixth*

- knows forms of radiant energy and their application to everyday life

*Seventh*

- knows uses of radiation, light, and thermal energy to improve the quality of life for human beings

*Eighth*

- extends and refines knowledge of uses of forms of energy to improve the quality of life.

**Benchmark SC.B.1.3.1** - The student identifies forms of energy and explains that they can be measured and compared.

### Grade Level Expectations

The student:

*Sixth*

- understands that energy can be converted from one form to another

*Eighth*

- understands that energy can be transferred by radiation, conduction, and convection

- knows examples of natural and man-made systems in which energy is transferred from one form to another.

**Benchmark SC.B.1.3.2** - The student knows that energy cannot be created or destroyed, but only changed from one form to another.

**Grade Level Expectations**

The student:

*Sixth*

- understands that energy can be changed in form
- uses examples to demonstrate common energy transformations.

**Benchmark SC.B.1.3.3** - The student knows the various forms in which energy comes to Earth from the Sun.

**Grade Level Expectations**

The student:

*Sixth*

- knows types of radiant energy that come to Earth from the Sun.

**Benchmark SC.B.1.3.5** - The student knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature.

**Grade Level Expectations**

The student:

*Eighth*

- knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature
- knows that the average kinetic energy of the atoms or molecules that make up an object changes when the temperature of the object changes.

### Rain Machine (Solar Still)

**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



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