

**National Science Content Standards:**

*A: Science as Inquiry*

*D: Earth Space and Science*

*F: Science in Personal and Social Perspectives*

**OBJECTIVE:**

To convey by means of visual representation how little freshwater is available to everyone in the world. To promote an understanding of the scarcity of freshwater and the need to conserve this resource.

**DESCRIPTION:**

Students will recreate the hydrosphere by means of containers and materials that represent various features of the hydrosphere (clouds, glaciers, surface water) and make observations of proportions and locations of freshwater available on Earth.

**MATERIALS:** (if conducting the experiment in groups, groups should take turns completing the experiment OR multiple sets of materials will be needed; one set per group.)

- Table - Percentages of Water on Earth (included)
- 1-gallon jug of water
- Small clear container (½ cup or 2 oz.)
- Cotton ball
- Ice cube tray
- Cup with sand or soil well-compacted
- 5" square of tin foil to cover surface of cup
- eye-dropper with Tablespoon, teaspoon and ml measurements
- Blue food coloring
- Tablespoon
- Teaspoon
- Pinch of salt
- Globe or picture of Earth from outer space

**Table. Percentages of Water on Earth<sup>2</sup>**

LOCATION	% of EARTH'S TOTAL WATER	% OF EARTH'S FRESH WATER
OCEANS	97.5%	-----
FRESH WATER	2.5%	-----
<i>Glaciers/Polar ice caps</i>		<i>68.70% of freshwater</i>
<i>Groundwater</i>		<i>30.10% of freshwater</i>
<i>Lakes, rivers, streams, swamps, ground ice, permafrost, etc.)</i>		<i>Surface: 0.30% of freshwater</i> <i>Permafrost: 0.86% of freshwater</i>
<i>Atmosphere</i>		<i>0.04% of freshwater</i>

## Where's the Water Worksheet - ANSWER KEY:

1. The surface of the Earth is about 71% water and 29% land.
3. 2.5 percent of the Earth's water is fresh. A gallon is 256 Tablespoons (Tbsp). 2.5 percent of 256 Tbsp is 6.4 ( $256 \times .025 = 6.4$ ). The 6.4 Tbsp represents all of the freshwater on Earth, 2.5% of the total amount of water on the planet. You should have removed 6 Tbsp and approximately 1 teaspoon (one teaspoon (tsp) is .33333 or 1/3 of a Tbsp).
4. Drinking, irrigation, industry, hydroelectricity (According to the EPA, It takes 39,090 gallons of water to make a new car, including the tires.)
5. Oceans comprise 97.5 percent of Earth's hydrosphere. There should be 249.6 Tbsp remaining, or 249 Tbsp and about 2 tbs. No, salt water is not suitable for the four human activities listed (unless you listed recreation, fishing, or travel). Salt water is corrosive to pipes and equipment, making it inefficient to use. However, since there is so much of it, research into its uses for human needs is ongoing!<sup>4</sup>
6. No, most of the freshwater on Earth is either not suitable or not accessible for drinking. Most of it is in glaciers or groundwater and much of the rest is polluted.
7. 0.04 percent of the Earth's total freshwater is in the atmosphere. 0.04 percent of 6.4 = 0.00256 Tablespoons. ( $6.4 \times .0004$ )  
  
1 Tbsp = 14.78 milliliters, and 1 milliliter = 0.0676 Tbsp: ( $1/14.78 = .0676 \rightarrow 0.00256 \therefore$  0.04 percent of 6.4 is less than a milliliter. (Although the atmosphere always has water, even when you can't see it as clouds, it is only about 0.001 percent of the Earth's total water volume. Rather than a destination or storage tank, the atmosphere is more like the route by which water travels elsewhere.)  
  
You are removing less than a milliliter to put in the cotton ball. Barely a drop!
8. The majority of the Earth's freshwater, or 68.6 percent, is found in glaciers and polar ice caps. You should remove 4.39 Tbps and place in the ice cube tray ( $6.4 \times .686 = 4.39$ ). The vast majority, almost 90 percent, of Earth's ice mass is in Antarctica. No, glaciers and ice caps are NOT salty. (You should have taken water from freshwater container.)
9. 30.1 percent of 6.4 = 1.9 Tbsp. This represents groundwater. (Groundwater is water that moves down into the ground because of gravity, passing between particles of soil, sand, gravel, or rock until it reaches a depth where the ground is filled, or saturated, with water. *Groundwater Foundation*.) Yes we are able to drink some groundwater, by pumping it through wells. But when we pump more than can be naturally replenished, we have to drill deeper, which is more expensive, can stress water tables, cause salt water to "intrude," and can decrease surface water since groundwater feeds surface water through springs and streambeds. Some groundwater is too deep underground to access. It is surprising how much more freshwater is stored as groundwater than as surface water.
10. This is surface water. Less than one percent of Earth's freshwater is stored as surface water (as opposed to being stored in the ground, or in glaciers) in lakes, streams, swamps and other water bodies. 1 percent of 6.4 = 0.064 Tbsp, or approximately one milliliter. This  $\leftarrow$ 1% of the Earth's freshwater – just a drop in the proverbial bucket of the **total** amount of water on Earth – is left to support most human (and animal) needs for agriculture, drinking, and washing as well as for lakes, rivers, and freshwater ecosystems.
11. Rivers feed lakes and reservoirs, so they are equally important!

Name: \_\_\_\_\_

1. Look at a map of the Earth or a globe. Estimate how much of the Earth's surface is covered with water? \_\_\_\_\_ Percent How much with land? \_\_\_\_\_ Percent

2. Fill a gallon jug with water; a gallon of water weighs 8.34 pounds. (Did you know that you probably used more than a gallon to brush your teeth this morning? In comparison, the average person in the African nation of Gambia uses only 1.17 gallons (4.5 liters) of water per day!) For the purpose of this experiment, this gallon of water represents ALL the water on Earth; the hydrosphere. (The amounts you will remove are representative and not exact scale equivalents, although very close! Approximate the amounts as closely as you can.)

3. How much water on Earth is FRESH? Let's find out. Review your Water on Earth chart. What percentage is fresh? \_\_\_\_\_ Using a dropper, remove that amount from the gallon container (remember it is the Earth's hydrosphere) and place it in the small clear container. How much did you remove? \_\_\_\_\_

Show how you calculated that amount? \_\_\_\_\_

Now add two drops of blue food coloring to make the water more visible.

4. Name four ways in which humans rely on water.

\_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_

5. The remaining water in the gallon represents the oceans, which comprise how much of our hydrosphere? \_\_\_\_\_ How many tablespoons should be left in the jug? \_\_\_\_\_ Tbsps.

Add a pinch of salt to the gallon jug to represent the saltwater in the ocean. Look at your answer to Question 4. Can humans use salt water for any of the needs you listed? \_\_\_\_\_

6. Is all the freshwater on Earth available to drink? Circle: YES or NO

Why or why not? \_\_\_\_\_

7. Some of the Earth's water is stored, temporarily, in clouds. What percentage of the planet's total freshwater is held in the atmosphere (or for the purpose of this experiment, the clouds)? \_\_\_\_\_

To create the equivalent percentage for your "cloud" how much water should you remove from the freshwater container? \_\_\_\_\_ Are you removing less than a milliliter? \_\_\_\_\_

Explain how you know. Because the amount is so small, remove a tiny drop from the container with the end of the dropper and place it on the cotton ball.

8. Comparatively little of the Earth's freshwater is in the atmosphere. Where (and how much) is the majority of the Earth's freshwater? \_\_\_\_\_ Use the tablespoon to remove that amount and place it in the ice cube tray. How much are you removing? \_\_\_\_\_

What does the ice cube tray represent? \_\_\_\_\_

Where is most of the ice on Earth located? \_\_\_\_\_

Are glaciers and ice caps salty? (You didn't remove the water from the "Oceans" did you?)

9. Use the tablespoon (or dropper) and remove 30.1 percent of total freshwater from the freshwater container and place in the cup with the sand. How much did you remove? \_\_\_\_\_

What does this amount represent? \_\_\_\_\_

Are we able to drink this water? \_\_\_\_\_

Compare the percentage with the percentage of surface water. Do the two numbers surprise you? \_\_\_\_\_

10. Observe the remaining blue water in the container. There should be barely any left!

Place the piece of aluminum foil on the surface of the cup filled with sand (and "groundwater"). Make a very small indentation in the foil with your finger (do not puncher the foil). Use the dropper and remove what remains of the blue water and place on the foil-covered cup. How much did you remove? \_\_\_\_\_ drops (How much SHOULD there have been left? Don't worry if it's not exact.)

What do you think this water represents? What is this water used for? Who uses it?

\_\_\_\_\_

11. Which are more important to humans as sources of freshwater, lakes or rivers?

\_\_\_\_\_

### WRAP-UP:

This activity illustrates that the world's supply of clean, fresh water is limited. In fact, even though Earth is called the Water Planet, as you just saw, only about 3% of all the earth's water is freshwater and of that tiny amount only about 1% is suitable for drinking water. *Why does that matter? Why should we conserve fresh water and protect it from pollution if there is always the same amount of water on the earth?*

### EXTENSION:

- Did you know it IS possible to make freshwater from ocean water? Desalination Plants, which remove salt from water, are an expensive to build and run and consume a lot of energy. There are very few places that can do this effectively for their communities. Click on the [STORY](#) about Australia's efforts to provide freshwater to their citizens. Discuss why or why not this might be a good idea for other communities around the world.
- Waste water. Would you drink it? Why or Why not? What other uses can you imagine for "grey" water? See *New York Times* story (2/10/2012) [http://www.nytimes.com/2012/02/10/science/earth/despise-yuck-factor-treated-wastewater-used-for-drinking.html?\\_r=1&emc=eta1](http://www.nytimes.com/2012/02/10/science/earth/despise-yuck-factor-treated-wastewater-used-for-drinking.html?_r=1&emc=eta1)

### SOURCES:

<sup>1</sup>Activity adapted from EPA: "All the Water in the World."

[http://www.epa.gov/region1/students/pdfs/ww\\_intro.pdf](http://www.epa.gov/region1/students/pdfs/ww_intro.pdf)

<sup>2</sup>USGS: <http://ga.water.usgs.gov/edu/earthwherewater.html>

<sup>3</sup>EPA: *National Water Quality Inventory: Report to Congress, 2004 Reporting Cycle, January 2009*

[http://water.epa.gov/lawsregs/guidance/cwa/305b/upload/2009\\_05\\_20\\_305b\\_2004report\\_report2004pt3.pdf](http://water.epa.gov/lawsregs/guidance/cwa/305b/upload/2009_05_20_305b_2004report_report2004pt3.pdf); page 9.

<sup>4</sup>USGS: <http://ga.water.usgs.gov/edu/gwdepletion.html>