

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
- Empty cup
- *eye-dropper with Tablespoon or teaspoon measurements
- *Blue food coloring
- *Tablespoon
- *Teaspoon
- *Pinch of salt
- *Globe or picture of Earth from outer space

**Younger students may perform the first experiment which requires minimal math dealing with percentages. Materials marked with an asterisk are for older students .*

Table. Percentages of Water on Earth²

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>

If younger students are not facile with percentages, simplify chart to:
Oceans = 97.5 percent; Freshwater = 2.5 percent.

EXPERIMENT - Grade 3 (or if time is constrained this may be used for grades 4 & 5 as well)

INTRODUCTION: Ask students to observe a photo of the Earth or a globe and discuss the following: What color do you see the most? Why? The blue is water, which covers almost 71 percent of the Earth's surface. This is about **139.4 million** square miles (361 million square kilometers). Most of that water, more than 97 percent, is in the oceans, and is therefore salty. *This experiment will help students better understand the relative proportions in the Table Percentages of Water on Earth by allowing them to visualize the amounts.*

Teacher activity instruction for younger students:

1. **Take turns holding the full gallon of water.** It weighs 8.34 pounds. This amount of water could be collected from the faucet in less than 30 seconds, most likely less than the amount you might use if you brushed your teeth without turning off the water. 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.
2. **With a dropper, remove 2.5 percent of total (6 Tbsp. plus 1 tsp.)** and place it in a clear container to represent the amount of fresh water on Earth. Add a few drops of the blue food coloring to this smaller container to make the water more visible.
3. **Add a pinch of salt** to the remaining water in the gallon container to represent the oceans.
4. **Remove 99 percent (6 Tbsp.) of the blue water in the smaller clear container** to represent approximately the amount of water trapped in glaciers or too deep in the ground to be recovered.
5. The water you removed is freshwater that can't be accessed for drinking water. **Name three reasons** why most of the freshwater on Earth is not available to drink?

(Hint: Where IS all the fresh water? **Second hint:** What happens to water when there are a lot of humans who make, use and throw away lots of STUFF?)

6. **What's left?** The remainder (in the clear container) – less than 1/10,000th of one percent of the Earth's total water supply – is left to support ALL human needs for agriculture, drinking, and washing as well as for lakes, rivers, and fresh water ecosystems. (Actually, not ALL the water underground is impossible to use. We do use a lot of it. But we have to be careful not to use too much!)

[Answer to question #5]

It is not all available because the freshwater is either: 1) frozen as glaciers at the North and South poles; 2) too far underground to be reached with a well; and 3) too polluted for use.

WRAP-UP: Of the Earth's freshwater, only a tiny amount - one percent - is found in lakes, rivers and streams. The remaining 99 percent is frozen in glaciers and polar ice caps, or deep below ground in groundwater. One percent of all the freshwater (about 1 tsp., or 1/10,000th of one percent of Earth's total water) is surface water, mostly rivers and lakes. It is truly a precious resource! Unfortunately, a lot of that surface water is polluted. *The U.S. Environmental Protection Agency found that 44 percent of the rivers and streams it tested in 2004 were determined to be "impaired."*³

Older students may conduct the experiment in groups, either taking turns or with their own set of the above materials per group. Complete the worksheet below.

1. The surface of the Earth is about 71% water and 29% land.
2. This amount of water was collected from the faucet in less than 30 seconds, the amount you might use if you brushed your teeth without turning off the water.
3. Oceans, lakes, rivers, clouds, glaciers, swamps, aquifers, marshes ... and more!
4. Clouds, or really the atmosphere. Although the atmosphere always has water, even when you can't see it as clouds, it is only about 0.001% of the total Earth's water volume. So rather than a destination or storage tank, the atmosphere is more the route by which water travels elsewhere.
5. The 6.5 Tbsp. represents all of the freshwater on Earth, 2.5% of the total amount of water on the planet.
6. No, only a small percentage of the Earth's freshwater is usable for drinking and other uses.
7. The ice cube tray represents frozen water. Out of all the fresh water, almost 70% is frozen in polar ice caps and glaciers. The vast majority, almost 90%, of Earth's ice mass is in Antarctica.
8. No, we can't access freshwater from glaciers or ice caps.
9. About 30% of our freshwater is stored in the ground, our lithosphere, as groundwater. Although some water can be pumped up into wells, most of the water is too deep in the ground to be recovered.
10. This is surface water. Less than one percent of our freshwater is stored as surface water (as opposed to being stored in the ground, or in glaciers) in lakes, streams and other water bodies. (Only .3% of freshwater is in lakes and streams!) This 1% of the Earth's freshwater (.007 % of the Earth's total water supply) – is left to support ALL human (and animal) needs for agriculture, drinking, and washing as well as for lakes, rivers, and freshwater ecosystems.

SOURCES:

¹Activity adapted from EPA: "All the Water in the World."

http://www.epa.gov/region1/students/pdfs/ww_intro.pdf and The Catskill Center for Conservation and Development's *A Sense of Place* curriculum: "Where is All the Water on Earth?"
http://www.catskillcenter.org/images/stories/pdf/module1_waterresources.pdf

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

³EPA: *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; page 9.

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!

3. Where on Earth do you think all of this water is located? List all of the types of bodies of water found on the planet:

4. Remove one tiny droplet of water with water dropper. Place the drop on the cotton ball. What do you think the cotton ball represents? Does it feel like a lot of water in there?

5. How much water on Earth is FRESHWATER? Let's find out. Remove 6 ½ tablespoons (Tbsp.) of water from the gallon with the dropper and place it in the small clear container. Add two drops of blue food coloring to this container to make it more visible. (If 6.5 Tbsp. is the amount of freshwater on Earth, and Earth holds 256 Tbsp. of total water - the number of Tbsp. in a gallon - what percentage of the total amount of water on Earth is freshwater? Use a calculator and divide 6.5/256.) Or, use the chart and determine the percentage.

_____ percent of the total amount of water on Earth is freshwater

6. The remaining water in the gallon represents the oceans, which make up 97.5% of our hydrosphere! Add a pinch of salt to the gallon jug to represent the saltwater in the ocean. Saltwater is not useful for most human activities.

Take a look at the freshwater in the chart. Is it all available for use? Why or why not?

7. Use the tablespoon to remove 4.5 Tbsp. from the freshwater container (68.6 percent of the 6.5 Tbsp.) and pour them into the ice cube tray. What does the ice cube tray represent?

Where is most of the ice on Earth? Are we able to drink water from glaciers and ice caps?

8. Use the tablespoon (or dropper) and remove 1.9 Tbsp. (30.1 percent of total freshwater) from the freshwater container and place in the cup with the sand.

Are we able to drink water from the ground?

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

Where do you think the remainder of the water in the world is stored?

10. Place the piece of aluminum foil on the surface of the cup filled with sand. Make a very small indentation with your finger; be careful not to puncture the foil. Use the dropper and remove what remains (\leftarrow 1% of freshwater) of the blue water and place on the foil-covered cup. What do you think this water represents? What is this water used for? Who uses it?

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** only a tiny amount is suitable for drinking water.

Why do you think it might be important to take care of this little amount of water?

Explain some ways that can help do this.

EXTENSION:

- Together with your class make your own pie chart of the Earth's water according to the chart above.
- 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.