

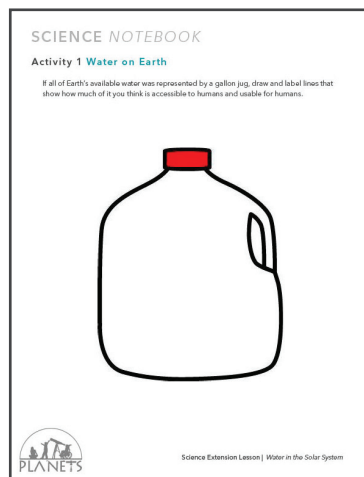
EDUCATOR *GUIDE*

Water on Earth (60 min)

Overview

In this activity, youth will learn that there are different reservoirs of water on Earth: on the surface, in the atmosphere, and underground. Only a small amount of all the water on Earth is usable for humans. Youth will learn about how chemical properties like salinity affect whether available water can be used by humans. Youth learn that much of the water that is not accessible or usable by humans is still habitable and used by other life forms.

In this activity:



Science Notebook

- » Two videos
- » Materials for salinity experiment. See page 20 for details.

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Introduction (5 min)

1. Explain to youth, that in order to understand how available, accessible, usable, and habitable water might be out in the solar system, we first need to understand these parameters for water on Earth.

Learning Goal: Water on Earth (10 min)

1. Ask youth: "How much of the Earth's water is fresh liquid water that we can use?" Ask youth to turn to a partner to discuss, then share.

2. Tell youth that we are going to look at different reservoirs of water on Earth. The word *reservoir* comes from the French "to reserve or save," so it means a place where something is stored - in this case, water.

3. Ask youth: "What are the different reservoirs of water on Earth?" *Accept all answers (oceans, rivers, lakes, clouds, glaciers, etc.).* Guide youth to the main categories: on the surface, in the atmosphere, and underground.

4. Ask youth: "Do you think some of the water in these reservoirs would be hard to get to?" *Yes, some water is too deep in the ocean, too deep underground or frozen in glaciers and ice sheets is not easily accessible.*

5. Ask youth: "Do you think there is liquid water on the surface that is too dirty or polluted to drink or use for washing?" *Yes, wouldn't you want to wash your clothes in swamp water or drink out of a polluted river. This water is not usable.*

6. Ask youth: "Why is fresh liquid water important?" *Fresh liquid water is important because that is the form of water that is used by humans.*

7. Ask youth: "How much of Earth's surface is covered by water?" *About 71% of Earth's surface is covered by water.* Remind youth that even though Earth has a lot of available water, not all that water is accessible and usable by humans.



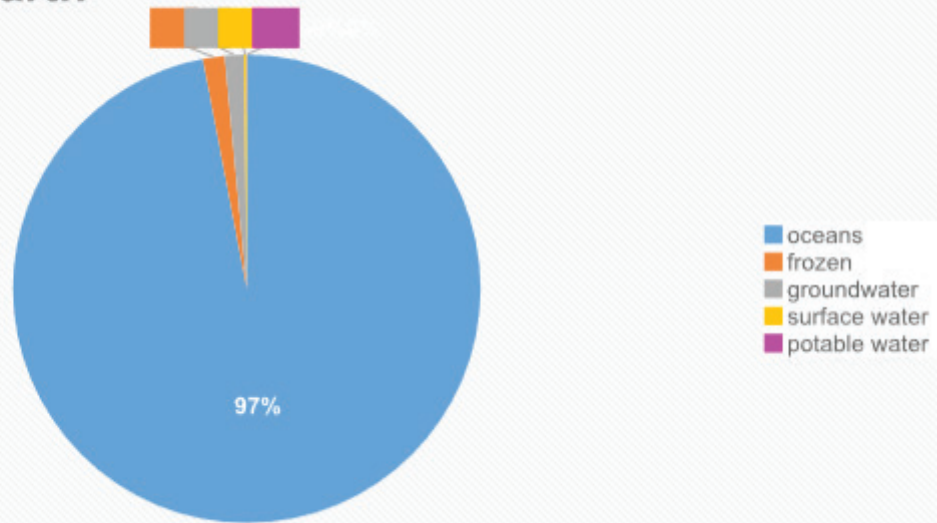
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8. In the science notebook on page 3, ask youth to make predictions on the water jug that represents all Earth's water. If all of Earth's water is represented by a gallon of water, then this is the amount of water available on earth. Label the whole jug 'available'.
9. Draw and label a line that represents the amount of water that is accessible by humans. Draw and label a line that represents the amount of water that is usable by humans.
10. Project *Earth's Water: Availability, Accessibility, and Usability*. This video can be found at www.planets-stem.org on the Water in Extreme Environments page in the Science Section. It is also [linked here](#) in the electronic version of this guide.
11. Have youth turn to page 4 in their science notebook and draw and label new lines on the *Water Availability on Earth* jug that represent accessibility, and usability.

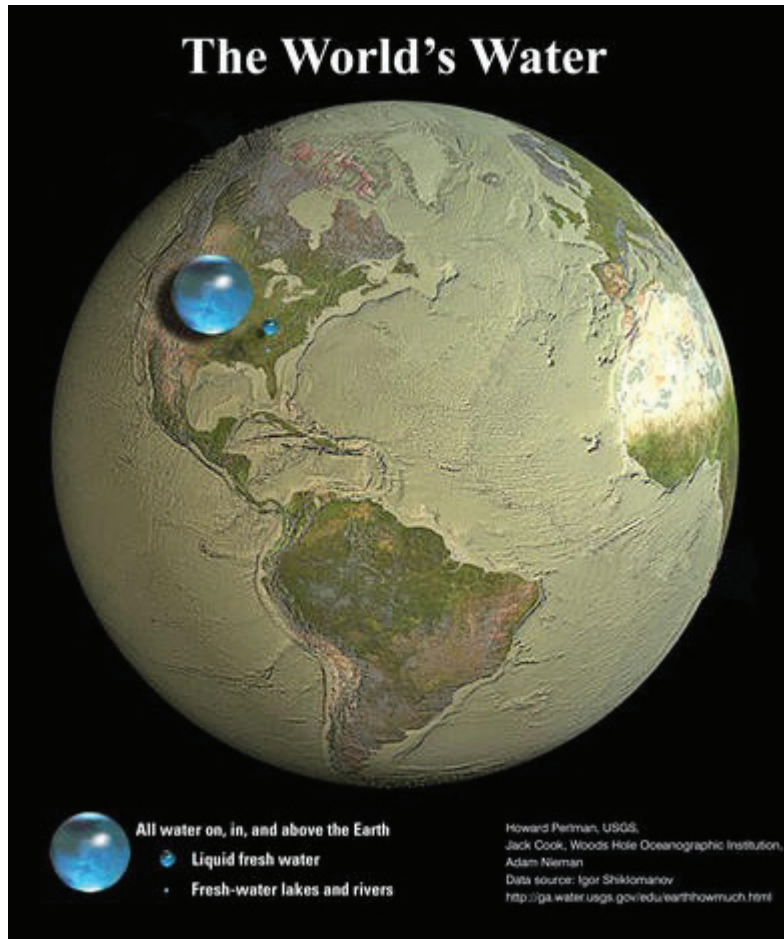
Optional Reference Visuals

	Explanation	Possible Water Reservoirs for Each
Availability	The presence or absence of water. How much water is available on Earth or another planetary body can be measured or estimated.	Subsurface, Surface, and Atmosphere
Accessibility	A measure of how easily water can be obtained. The more effort or energy it takes to access water depends on its location and its physical state.	Surface and Atmosphere (as rain only).
Usability	A measure of how usable water is for human consumption, agriculture, and hygiene.	Shallow subsurface, Surface, and Atmosphere (as rain only).

Water on Earth



The World's Water



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Water Usability on Earth - Dissolved contaminants (20 minutes)

1. Ask youth: "What would make water not drinkable?" In Activity 1, we saw how little drinking water there is on the Earth. If they have done the Engineering Everywhere™ Testing the Waters Unit, they learned how to filter water to remove pollutants.

Tip: If youth have completed the Engineering Everywhere™ Testing the Waters Unit, they will have investigated pH and filtering to alter the pH of waste or gray water. Also consider adding acidity to the discussion after showing this video <https://www.youtube.com/watch?v=I18K2upEHLc>

2. Explain to youth that on planets, the salinity of water is affected by different things that are dissolved in it.

3. Salinity Experiment:

- » Split youth into groups of 3 or 4. For every group, you will need:
 - i. 2 clear plastic cups
 - ii. 1 marker
 - iii. 3-4 tablespoons of salt
 - iv. 1 Tablespoon
 - v. 1 Stirring spoon or stick
 - vi. 2 potato slices
- » Have a representative in each group label the 2 cups saline water and pure water.
- » Have another group member fill the two cups with an equal amount of water.

Tip: This experiment takes 24 hours to show results. Depending on the time structure of your program, you may want to set up this experiment yourself the night before so that you can discuss the results with youth the same day they set up their own investigation.

Tip: In general, the more salt you dissolve, the warmer the water, and the more surface area exposed on the potato, the more dramatic the results will be.

EDUCATOR GUIDE

- » Have another group member stir in 3-4 tablespoons of salt one at a time to the cup that says saline water.
- » Have another group member add a potato slice to each cup.
- » Let cups sit out overnight.
- » Observe the differences the next day. Note the size and consistency differences. Did the potato slice in the saltwater shrivel? Does it bend or break? Does it feel hard and crisp or limp and soft?

4. Let youth know that potatoes have actually dehydrated from sitting in saltwater. If you drink water that is too salty then it will dehydrate you just like the potato. There is actually less water inside the potato that sat in saltwater. This makes it flimsy and not as crisp.

Tip: If youth have questions about how salinity dehydrated the potato, consider showing this video: <https://www.youtube.com/watch?v=jzTBR2APU-k>

Tip: If you have access to a microwave or hot water tap, have youth experiment with the difference temperature makes when dissolving the salt. If you have additional time, you can also experiment with stirring or not and/or time how long it takes for the salt to dissolve in hot versus cold water, with stirring or not.

Discussion (5 min)

1. Have a group discussion about salinity using the following guiding questions:
 - » Do you know what salinity means?
It means the amount of salt dissolved in water.
 - » Why does the salinity of water matter?
Too much salt in the water makes it unhealthy to drink.
 - » Does it matter just for humans?
No, it also matters for fish and other aquatic creatures in the water and for plants and animals both in the water and near the water.
 - » Why can some fish and plants live in salt water?
Fish adapt to live in salty water by peeing out salt, or in fresh water by absorbing salt in their gills, but nothing can live in water that has very high salinity.



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Water habitability on Earth - Video and discussion of extremophiles (15 min)

1. Explain that water requirements for human use are different than the water requirements for other life forms. Habitability is the ability of an environment to support life.

2. Have a group discussion about water habitability using the following guiding questions:

» What does most life on earth need to survive?

Most life needs liquid water, relatively neutral pH, moderate temperatures, and an energy source (the sun).

» Are these the requirements for all life? *Accept all answers.*

» If ocean animals have adapted to salinity, is it possible that life on earth has adapted to other pollutants or extreme environments? *Accept all answers.*

» Do you know any examples of life that live in extreme environments without abundant water, high or low acidity, or without sunlight here on earth? *Accept all answers.*

5. Show the following NASA eClips video about extremophiles:

<https://www.youtube.com/watch?v=DVox3i1pcpQ>

6. Ask youth: "So now what do you think are the requirements for life on Earth?"

As we know it on earth, a habitable environment is one that has water, a source of carbon for organism metabolism, and a source of energy to fuel that organism's metabolism.

Wrap Up (10 min)

1. Lead a discussion to summarize the availability, accessibility, usability and habitability of water on earth. Use the following questions to guide the discussion:

» If most of the Earth's surface is covered in water, why is drinking water limited for human use?

Because most of it has high salinity (ocean water), and much of the water that is usable is not easily accessible (locked up in ice sheets or underground).

» What technologies have humans devised to treat dirty water for human use?

Filters and sewage treatment plants.

» Is there a difference between the usability of water for humans and the

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habitability of water for other life forms?

Yes, humans need pure liquid water. Most lifeforms live off water that is not accessible or usable for humans. In fact, if water is habitable and lots of things live in it, then it's contaminated for human use.

- » Do you think other planetary bodies that have water might have the same issues?
Sure they do! Let's check it out in the next activity.

