How Blue is Our Planet? How Green are You?

LEVEL
Grade 5 Math and Science

MODULE
Graphical Displays

MODALITY
NMSI emphasizes using multiple representations to connect various approaches to a situation in order to increase student understanding. The lesson provides multiple strategies and models for using those representations indicated by the darkened points of the star to introduce, explore, and reinforce mathematical concepts and to enhance conceptual understanding.

P – Physical
V – Verbal
A – Analytical
N – Numerical
G – Graphical

ABOUT THIS LESSON
In this lesson, students make a prediction of how much of the planet is covered by water and then perform an experiment with an inflatable globe to determine the percentage of water and exposed land on earth. Students determine that about 70% of the earth is covered in water and use a 100 mL graduated cylinder to represent the water on earth. Next, students analyze the breakdown of the water as salt water and fresh water on Earth and then go further to understand the amount of ground water, surface water, and water that is in the form of glaciers and ice caps. Lastly, students determine how much water their household uses showering. As students work through these activities, they must model each experiment or activity, perform mathematical calculations, create graphs and tables, and analyze the data to support their predictions and conclusions.

OBJECTIVES
Students will

- predict how much of the earth is covered by water or exposed land and perform an experiment to confirm their prediction.
- create a model to represent the amount of salt water and fresh water on Earth.
- create a model to represent the distribution of fresh water on earth as ground water, surface water, and glaciers and ice caps.
- use real world scenarios and data to create graphical displays such as picture graphs, bar graphs, line plots and circle graphs.

- use graphical displays including bar graphs to solve “how many more” and “how many less” problems.

CONNECTION TO COMMON CORE STANDARDS FOR ENGLISH LANGUAGE ARTS

The activities in this lesson allow teachers to address the following Common Core Standards:

Targeted Standards

5.NF.6: Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *See Activity 2, question 5; Activity 5, questions 7, 10c-d, 11*

5.MD.2: Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally. See Activity 5, question 8*

Reinforced/Applied Standards

4.MD.6: Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure. *See Activity 3, question 6; Activity 4, question 5*

4.MD.7: Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure. *See Activity 3, question 6; Activity 4, question 5*

4.NF.5: Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. *For example, express 3/10 as 30/100, and add 3/10 + 4/100 = 34/100. See Activity 2, questions 3-4*

4.NF.6: Use decimal notation for fractions with denominators 10 or 100. *For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram. See Activity 4, question 2*

COMMON CORE STATE STANDARDS FOR MATHEMATICAL PRACTICE

These standards describe a variety of instructional practices based on processes and proficiencies that are critical for mathematics instruction. NMSI incorporates these important processes and proficiencies to help students develop knowledge and understanding and to assist them in making important connections across grade levels. This lesson allows teachers to address the following Common Core State Standards for Mathematical Practice.

MP.2: Reason abstractly and quantitatively. *Students make a connection between the amount of water on the Earth and represent it in a graduated cylinder as 100 mL in order to understand the breakdown of the amount of salt water and fresh water on the planet.*

MP.4: Model with mathematics. *Students begin with the overarching question “How blue is our planet?” to explore the breakdown of the amount of water on the Earth that is salt water and fresh water in order to analyze how* *much water the total water on the planet is available for daily use. Students begin with 100 mL of water to represent 100% of the water on Earth to create a visual model to understand that only 3% is fresh water and of that 3%, less than 1% is water that is available for daily use. Students then model this data in bar graphs and circle graphs. They are able to make connections by looking at the small portion of each mathematical representation that is shaded for fresh water that out of all the water on the Earth, we are only able to consume a small portion. Lastly students explore how much water they use by taking a shower each day and use all of the data to think about ways in which they can conserve water.*

MP.5: Use appropriate tools strategically. *Students use an inflatable globe to perform and experiment to determine the percentage of exposed land vs. water on the Earth. Students utilize different sizes of graduated cylinders and multiple graphical representations to model data to create multiple visual representations of the percentages of salt water and fresh water on the Earth.*

NEXT GENERATION SCIENCE STANDARDS

5-ESS2-2: Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

MATERIALS AND RESOURCES

- Colored Pencils
- 100 mL Graduated Cylinder (2 per group)
- 10 mL Graduated Cylinder (3 per group)
- 1 mL Pipette
- Blue Food Coloring
- Salt Packet
- Inflatable Globe
- Grid Flipchart Paper
- http://www.usgs.gov
- http://water.usgs.gov/edu/wetstates.html
- http://www.kingcounty.gov/environment/waterandland/groundwater/education/animation.aspx

ASSESSMENTS

Formative assessments:

- Students interpret information from graduated cylinders to create bar graphs, line graphs, circle graphs, and pictographs.
- Class discussion on the percentage of area of exposed land vs. water on the Earth.

TEACHING SUGGESTIONS

Most students know that water is a natural resource that must be protected from pollution. Students may not understand, however, the scarcity of the resource. Despite the fact that Earth is often referred to as the Water Planet, most of the water on Earth is saline and therefore not suitable for use by most plants and animals. The small percentage of the water that is fresh is located in areas that are not easily accessible.

Rapidly increasing human populations are putting increased pressure on the limited resource of fresh water. As populations grow, so does the demand for fresh water for human consumption, agriculture, and manufacturing. As increasing human populations put pressure on the limited water supply, they also produce greater amounts of pollution that foul the available water supplies. Further complicating the situation is climate change which is causing prolonged periods of drought, such as is being experienced in California. California produces much of the produce that is consumed in the United States. The current drought will result in decreased food supplies and increased food prices.

During the first activity, **"How Blue is our Planet?"** students will use an inflatable globe to help determine what fraction of the Earth is covered by water. As you begin this lesson ask "Why do we have water on Earth?" Add into the conversation that the Earth is big enough (has large enough mass) to generate sufficient gravitational force to hold on to our atmosphere. The atmosphere keeps Earth's water from drifting into space. Earth is also the right distance from the Sun to have liquid water. Planets closer to the Sun, such as Venus, only have trace amounts of water in its atmosphere due to very high surface temperatures. Planets further from the Sun, such as Mars, only have water frozen beneath its surface. The Earth is "just right;" the right size and the right distance from the Sun, which is why we have water on the Earth. Next ask, "Why is water important to life?" Water is referred to as the "universal solvent," meaning just about everything dissolves in water. Almost all of the chemical reactions needed to support life occur in water. If there was no liquid water there would be no life, as we know it. Finally, the oceans serve as the Earth's "thermostat." They absorb and retain heat energy from the Sun, thus maintaining the climate in a range of temperatures that supports life in the various biomes on Earth. Have students examine the inflatable globes and observe the areas of land and oceans. If students do not point it out, the teacher should remind students that the Arctic and Antarctic regions are covered with ice sheets, and therefore considered to be water. Students make a prediction and then use the fraction model to shade how much of the Earth's surface is covered in water versus exposed land. The fraction model is in tenths to help students think in terms of percentages being out of 100.

After students make their predictions, they will perform an experiment in Activity 2, **"You've Got the Whole World in Your Hands."** For this activity, students should put a dot on either their left or right index finger with a pen or marker. In groups of three, students will have a data recorder and two people to perform the globe toss. One student will toss the globe to the other student. Once the student catches the globe, they should lift up their marked index finger and see if the area under the dot is "land" or "water". If the dot seems to hover over both "land" and "water", students should flip a coin or use a spinner to determine which designation to use. Have students change roles after 10 tosses. The rotation continues until 100 tosses are completed. Students should use tally marks to record their results in the provided table and then add up the tosses for each column and express their data as two ratios:

$$\frac{\text{total tosses for land}}{\text{100 tosses}} \text{ and } \frac{\text{total tosses for water}}{\text{100 tosses}}.$$

Lastly, students express their fractions as a percentage by multiplying each fraction by 100. Compare the actual amount of about 71% of the Earth is covered by water to the experimental data, and also to the students predicted amount of water in Activity 1.

Now that students have determined that about 70% of the earth is covered with water, they will create a model that represents the distribution of salt water and fresh water in Activity 3 **"Water, water, everywhere, nor any drop to drink."** Before reading the passage, ask students if all of water on Earth is suitable for drinking. Next read, with the students, the introduction to Activity 3. Ask students to predict how much water on the planet is salt water and how much is fresh water. Provide students with 100 mL of water to represent all water on Earth (100% of the water on Earth), then remove 3 mL, using the 1 mL pipette, from the 100 mL to represent the amount of fresh water, since 3% of water on the planet is fresh water. Add a packet of salt to the remaining 97 mL to represent the amount of salt water on the planet since 97% of the water on Earth is salt water. Drinking **salt water** will cause cells in most organisms to shrivel and die. Although salt can be removed from water, it is a difficult and expensive process. Take time to talk about the significance of the small percentage of water on the planet that is **fresh water**. Fresh water is defined by having a low salt content, usually less than 1%. Fresh water can be found in multiple places such as ice sheets, ice caps, icebergs, glaciers, rivers, lakes, streams, and aquifers. Humans use this water for drinking, cleaning, bathing, sewage, cooking, and many other purposes, and wildlife also uses the fresh water. Fresh water does not mean that it can be consumed directly without purification first. Fresh water is susceptible to bacteria, pollution, and other contaminants.

Students conclude the activity by creating a diagram illustrating the amount of salt water and fresh water in each graduated cylinder and create a bar graph and circle graph to represent the data. Remind students to label each model appropriately.

Students extend this activity in **"How Much Fresh Water Do We Really Have Left?"** to explore the distribution of fresh water on the planet as ground water, surface water, and glaciers and ice caps. Explain to students that they will need to use only the 3 mL that represented the fresh water from Activity 3. Ask students to predict how many milliliters will represent the amount of ground water, surface water, and glaciers and ice caps. To begin the activity, have students pour the 3 mL representing fresh water into a 10 mL graduated cylinder. Ask students why pouring the 3 mL of water into a smaller graduated cylinder makes sense and have them record their answer in question 1. Since students will be removing 0.04 and 0.9 mL from the graduated cylinder, it would be beneficial for students to represent these two numbers on a number line in question 2 to understand how much water they need to add to the pipette to represent surface water and ground water. Show students the connection of the number line and the measurement scale on the pipette to assist in removing the appropriate amount of water each time. To represent the amount of available surface water, students will need to remove 0.04 mL from the graduated cylinder with 3 mL. Remind students that this is only about drop they are removing from the 3 mL into an empty graduated cylinder. Use the same process to remove 0.9 mL from the graduated cylinder with the remaining 2.96 mL of fresh water and place the water into an empty 10 mL graduated cylinder. The remaining water, the 2.06 mL of fresh water, now represents the amount of fresh water in glaciers and ice caps.

Take time to discuss the significance of the representation of each type of water. About 30% of the fresh water on the planet is ground water, represented by the 0.9 mL of fresh water. **Ground water** is water found beneath the Earth's surface in the cracks and spaces in soil, sand, and rock. It is the water flowing through aquifers and underground streams. Ground water also helps grow our food through soil moisture and can be used for irrigation for crops. Unfortunately, ground water is very susceptible to pollutants such as road salts, fertilizers, chemicals, trash, gasoline, and oil which cause it to become unsafe and unfit for human use. Students can learn more about ground water at http://www.kingcounty.gov/environment/waterandland/groundwater/education/animation.aspx.

Glaciers and ice caps are the largest reservoir of the fresh water on earth, about $68\frac{2}{3}\%$, represented by the 2.06 mL in the graduated cylinder. A **glacier** is a body of dense ice that is constantly moving under its own weight, whereas an **ice cap** is a large body of ice that does not move. Glaciers form over a period of years when more snow falls than melts. The snow compacts into ice and becomes thick enough to begin to move. Almost 10% of the world's land mass is currently covered with glaciers, mostly in places like Greenland and Antarctica. A massive ice cap can be found in Greenland, a country that is nearly covered in ice. The ice on Greenland is approximately 2 miles in thickness in some places. This form of fresh water could be melted; however, it is too far away from where people live to be usable.

About $1\frac{1}{3}\%$ of the fresh water on the Earth is surface water, represented by the 0.04 mL of fresh water in the graduated cylinder. **Surface water** can be found on the surface of the Earth in streams, rivers, lakes, reservoirs, and wetlands. It is replenished by precipitation and by ground water rising to the surface. It is lost through evaporation and seepage into the ground.

In question 5, students are asked to create a circle graph of the data. If students do not recall how to create a circle graph with 3 sectors, have them measure and shade the sector for ground water. Have students add the angle measurements for ground water and surface water, $108^\circ + 5^\circ = 113^\circ$. Measure the 113°, angle and shade it with a light color. Go back to 108° and mark the angle then shade over the portion of the angle between 108° and 113°, which measures 5°, with a darker color and label as surface water. Shade the remaining portion of the circle with a different color to represent glaciers and ice caps.

Conclude this activity by revisiting the amounts of ground water and surface water, water which is available to us, which is only small portion of water on the planet that we can use. Discuss with the students how much water is around us and how much we use each day. Lead the conversation by posing questions such as "How much of the total land area of the United States is covered by water? (Only 7% of the area of the United States is covered by water.) How much of the area of our state is covered by water? Which state do you think has the highest percentage of area covered by water?"

For more information on the area of water covering individual states visit http://water.usgs.gov/edu/wetstates.html.

In the last activity, "**Down the Drain,**" students are provided an opportunity to determine how much of the fresh water they use just by taking a shower. Begin this activity by asking "How much water do you think you use each day?" It may be necessary to encourage students to list ways in which they use water, such as brushing their teeth, flushing the toilet, drinking water (remind them that tea, sodas, energy drinks, etc. are also made from water), washing dishes or clothes, etc. before making this prediction. According to the U.S. Geological Survey, the average person uses 80 – 100 gallons of water per day. Most of this water is used to flush the toilet and for bathing.

In this activity, students predict how many gallons of water they use when they take a shower. It is important to remind students this this is the amount of time from when they first turn on the shower until they turn the water off. At this time, the teacher could have each student write their prediction on an index card and the teacher keep them until they collect their own data to compare the actual versus the predicted amount. Students are then assigned to collect data for the amount of time the water is running for each household member to take a shower. When students return with their data, they will compute the amount of water each person uses for a shower. Remind students to use the appropriate amount of gallons per minute provided for the showerhead model in their house. Students then post their data for the number of minutes the shower is running on a class line plot and create a pictograph of the class data for the number of gallons of water used by each person for a shower (to the nearest gallon). Before students create the line plot or pictograph, ask students for the maximum amount of minutes and gallons and help them create a scale for the number of minutes on the line plot and the number of gallons on the pictograph. To end this activity, ask students to write a concluding paragraph on what they can do to conserve water.

Additional information can be found at http://www.usgs.gov/.

How Blue is Our Planet? How Green are You?

Activity 1: Introduction

Look at the picture of the Earth taken from the Space Shuttle. It is easy to see why the Earth is sometimes referred to as the "Blue Planet". What do you think is responsible for all of the blue color in the picture?

The fact that there is liquid water on Earth makes it stand out from other planets. If there was not liquid water on Earth there would not be life, including us, on the planet. Why is liquid water so important to life? Think for a moment about what happens when you add sugar to a beverage such as lemonade, tea, or coffee. What happens to the sugar? It dissolves. Think about the food you ate for breakfast. All of the nutrients that were contained in the food you ate was digested and mixed in the water that is part of your blood. The blood then transports the dissolved nutrients throughout your body. The oxygen you inhale, the carbon dioxide you exhale is moved through your body in components that are found in the watery portion or plasma of your blood. Almost everything your body needs for survival is dissolved in water. Even the waste products your body needs to rid itself of are dissolved in water. Every living organism, whether a single celled amoeba or a 200 ton Blue Whale, relies on water to live.

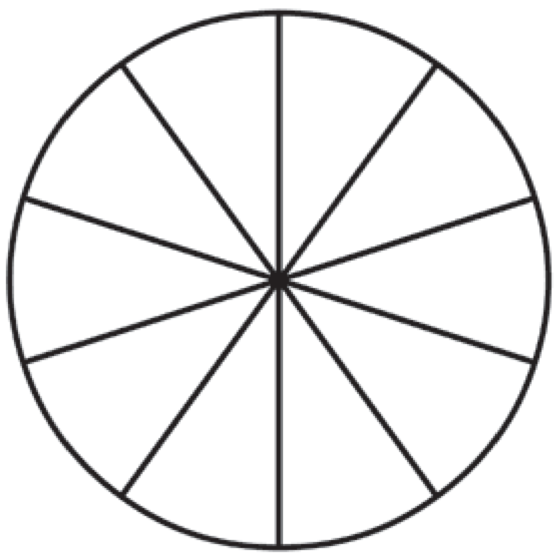
Water also keeps the Earth's temperature at a level that supports life. The Earth's oceans are like the thermostat in your house. They keep the temperature at a comfortable setting. All of the water in the oceans can absorb and release heat energy that comes from the Sun. The heat energy that moves through the oceans maintains the different climates and therefore ecosystems such as tundra, deserts, and tropical rainforests exist on our planet. Water needs to gain a lot of heat energy before it boils and lose a lot of heat energy before it freezes. The fact that we have so much liquid water on Earth allows us to have climates in which living organisms can survive and thrive.

Why does Earth have liquid water? It's all due to Earth's size and position relative to the Sun. Do you remember the story "Goldilocks and the Three Bears?" One bowl of porridge was too hot for Goldilocks, one was too cold but the final bowl was "just right" (but what was she doing in the Bears' house anyway?). It is much the same for Earth; our home is just the right size to have enough gravity to keep an atmosphere close to its surface. That atmosphere keeps Earth's water from escaping to space. Earth is also just the right distance from the Sun. If Earth was any closer to the Sun all of our water would have boiled away into the atmosphere as it has on Venus. If Earth was further away from the Sun, its water would be all frozen as it is on Mars. The Earth is just the right size to have an atmosphere that the water can cycle through. It is just the right distance from the Sun so that not all of our water is either evaporated into a gas or frozen into an icecap. Goldilocks must love the Earth; just like her favorite bowl of porridge, it's "just right".

We have established that Earth is sometimes referred to as the "Blue Planet," but just how much of Earth is covered with water?

1. Looking at the globe, do you see more water or exposed land?

2. Create a fraction model.
   a. How much of the Earth's surface do you think is covered by water? Shade the fraction model with a blue colored pencil to show the amount of the Earth that is covered by water.
   b. How much of the Earth do you think is exposed land? In other words, land that shows above the water. Shade the fraction model with a brown colored pencil to show the amount of Earth that is exposed land.



   c. What fraction represents the total area of the Earth covered by water and exposed land?

3. Are the land masses equally distributed around the globe?

4. Are there more oceans on one part of the globe than another?

5. Using your globe, can you and your team devise a method for determining about how much of Earth is covered with water? Describe your method.

Activity 2: You've Got the Whole World in Your Hands!

You and your team will estimate the **percentage**, the part out of 100, of the Earth that is covered with water by tossing the inflatable globe to one another. You will do this by gently tossing the globe to a team mate and recording if a dot on one of your fingers lands on land or water. Your team will do this for a total of 100 catches, so you can express your results as a fraction of 100 or a percentage.

Directions:

- Each team member should draw a small dot on the tip of their right index finger.
- Team members will gently toss the globe to each other. The team member catching the globe will do so with both hands and will announce the number of the toss.
- Once the globe is caught, the team member who caught it will slightly lift their right index finger and determine whether the dot on the tip of the finger is resting on water or land.
  - If the dot is on the ice masses of the Arctic and Antarctic, the catch counts as having landed on water.
  - If the dot is on a both land and water, flip a coin to determine if the toss counts as land or water. If the coin flip is heads, then the toss counts as water. If the coin flip is tails, then the toss counts as land.
- One member of the team will record the results on the Data Table
- Switch data recorders after every ten tosses of the globe.

Data Collection

Use tally marks for each toss to record if the tip of your finger was on land or on water.

Land	Water
Total Tosses for Land:	Total Tosses for Water:

Questions

1. Determine the fraction of tosses for land and water.

$$\text{Land: } \frac{\text{Total Tosses for Land}}{100 \text{ tosses}}$$

$$\text{Water: } \frac{\text{Total Tosses for Water}}{100 \text{ tosses}}$$

2. If you add the fraction of tosses that indicate land and the fraction of tosses that indicate water, what should the sum equal?

3. Add your group's fractions for land and water. What is the sum?

4. Change your fraction to a percentage by multiplying the fraction by 100. What percentage of the Earth is covered by water? What percentage of the Earth is covered by land?

5. Compare your results with the other groups in the class. Are all the percentages close to your team calculation from the globe toss data?

Activity 3: "Water, water, everywhere, nor any drop to drink"

Samuel Coleridge's long poem "The Rime of the Ancient Mariner," is a tale told by an old sailor, the Ancient Mariner, about one of his voyages. His ship was caught in a storm and eventually reaches Antarctica. An albatross, a large white ocean bird with very long wings, appears and leads them out of the Antarctic. (Wilbur in the movie "Down Under" is also an albatross.) The crew believes the bird brought them good luck. When the mariner shoots the bird, they believe he has brought them bad luck. They force him to wear the albatross around his neck. After being lost at sea for days, the mariner exclaims" water, water everywhere, nor any drop to drink" because they are surrounded by salt water but don't have any drinking water left aboard. The crew decides to drink the salt water anyway. Because they drank only salt water, they lose their minds.

In the previous activity, we discovered that approximately 70% of the Earth is covered with water. In this activity you will determine what fraction of 100, or percentage, of the water on the "Blue Planet" is suitable to drink.

Let's begin with a model that represents all of the water on Earth. A model is a representation of something that is difficult to observe directly. In this model we will use 100 mL of water to represent all of the water on the planet. Answer the questions on your student data sheet.

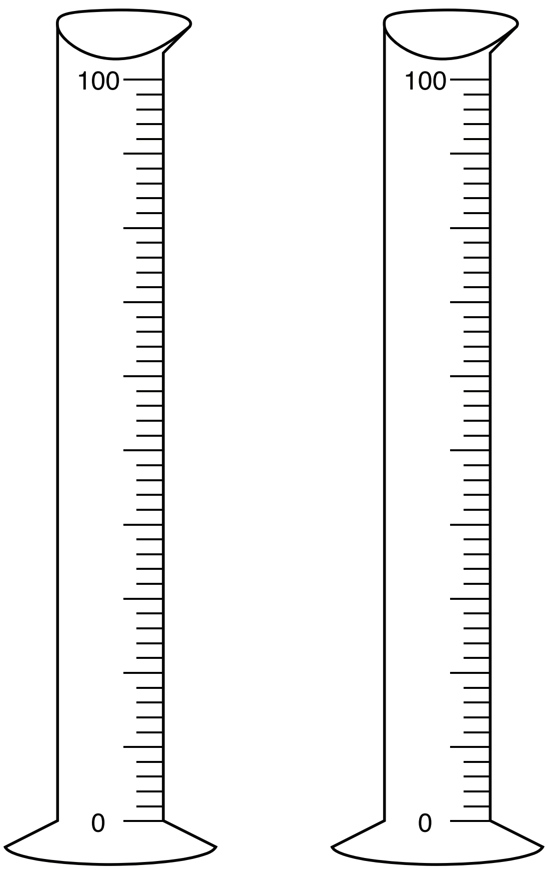
Directions:

- Pour 100 mL of water into a 100 mL graduated cylinder. This represents all of the water on Earth.
- Pour 3 mL of water from the 100 mL graduated cylinder into an empty 100 mL graduated cylinder.
- Add a pinch of salt to the 97 mL of water.

Questions

1. Do you think that all water on the planet is drinkable? Explain.

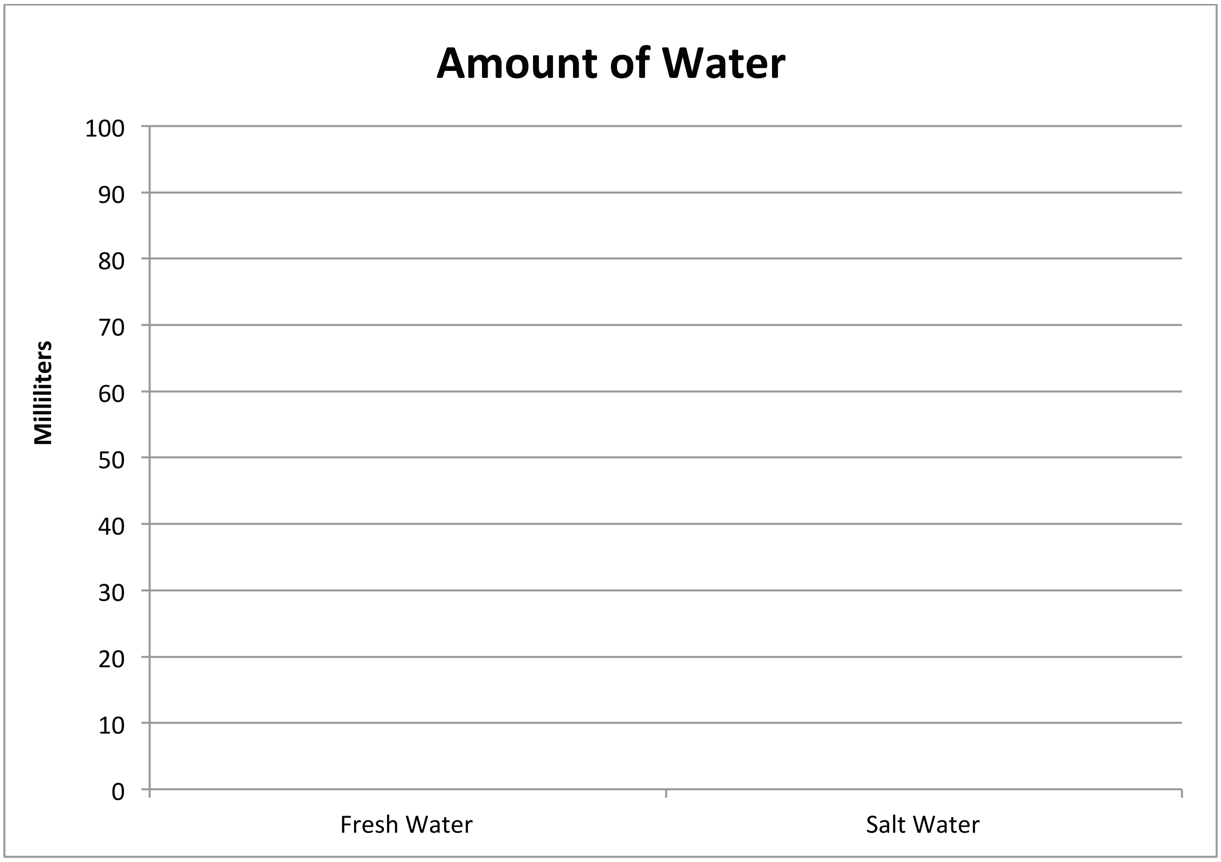
2. Draw and label a model that represents the amount of water in each graduated cylinder and label what each cylinder represents salt water or fresh water. Indicate the water level in each graduated cylinder.



3. How many milliliters of water represent the total amount of drinkable water on the planet?

4. Why isn't all of the water drinkable?

5. Based on your diagram of the two 100 mL graduated cylinders, create a bar graph that represents the amount of drinking water and salt water on the planet.



6. A circle graph, or pie chart, represents data as "slices of pie" or a sector of a circle. Which type of water, fresh or salt, would be represented by the largest "slice" or sector of the circle? ________________

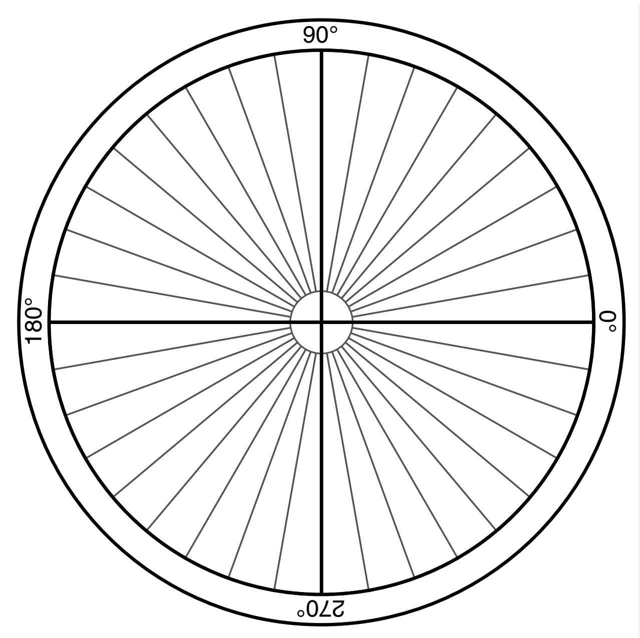
   a. To determine how big of a "slice" or sector of the circle will represent the saline water on Earth:

   $$\frac{\_\_\_\_\text{ml of salt water}}{100\text{ ml of water}} \times 360^{o} = \_\_\_\_\_\_\_\_\_\_\_\_$$ (round the answer to the nearest whole number)

   b. To determine how big of a "slice" or sector of the circle will represent the fresh water on Earth:

   $$\frac{\_\_\_\_\text{ml of fresh water}}{100\text{ ml of water}} \times 360^{o} = \_\_\_\_\_\_\_\_\_\_\_\_$$ (round the answer to the nearest whole number)

   c. Create a circle graph by shading the angle that represents fresh water. The remaining part of the circle can be shaded to represent the amount of salt water. Label each sector with the name and the fraction that each sector represents. Add a title to the graph.



Activity 4: How Much Fresh Water Do We Really Have Left?

In the previous activity we created a model that represented all of the water on Earth. We determined that only 3% of the water on Earth is fresh. The 3% of the water that is fresh can be categorized as ground water, surface water, and glacier and ice caps.

For this activity we will be using three 10 mL graduated cylinders.

- Pour the 3 mL of fresh water into one of the 10 mL graduated cylinders.

- Use a pipette to remove 0.04 mL into an empty 10 mL graduated cylinder. This will represent the amount of available surface water available.

- Use the same process to remove 0.9 mL into an empty 10 mL graduated cylinder. This will represent the amount of available ground water.

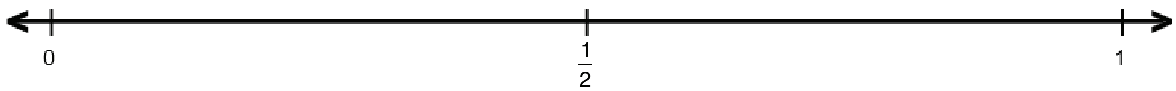
- The remaining water in the initial graduated cylinder represents the amount

  of water in glaciers and ice caps. ________ mL of water is remaining in this cylinder.

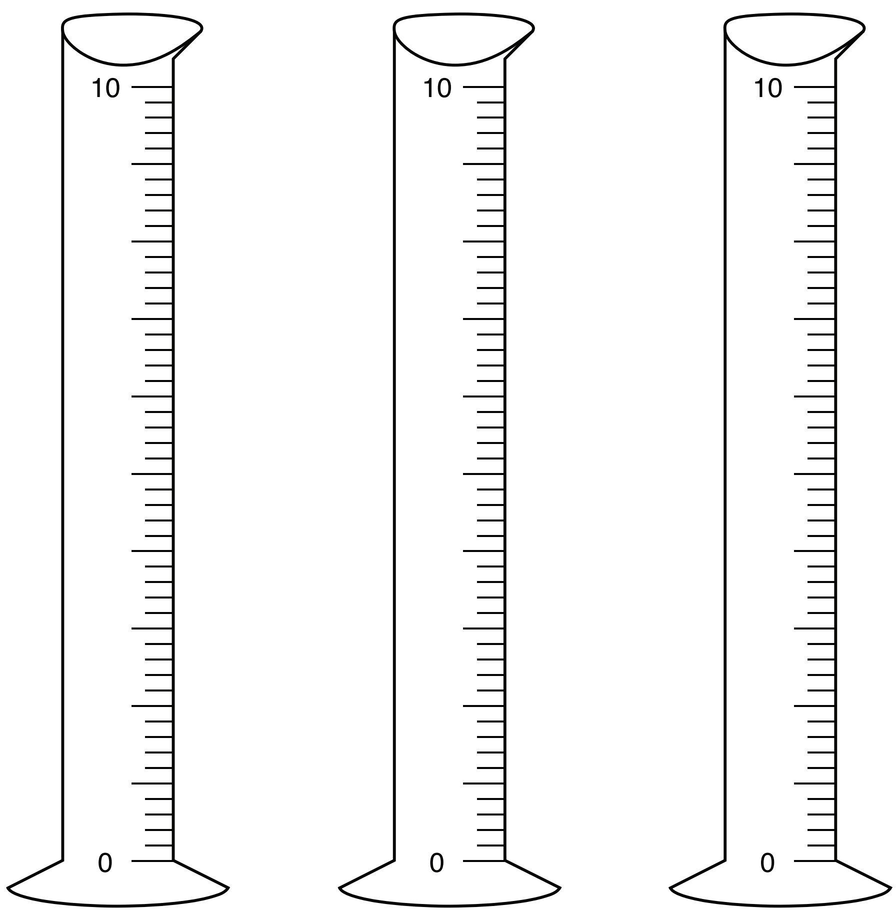
Questions

1. For the last activity we used 100 mL graduated cylinders. Would it be best to use a 100 mL graduated cylinder or a 10 mL graduated cylinder to measure portions of 3 mL of water? Explain.

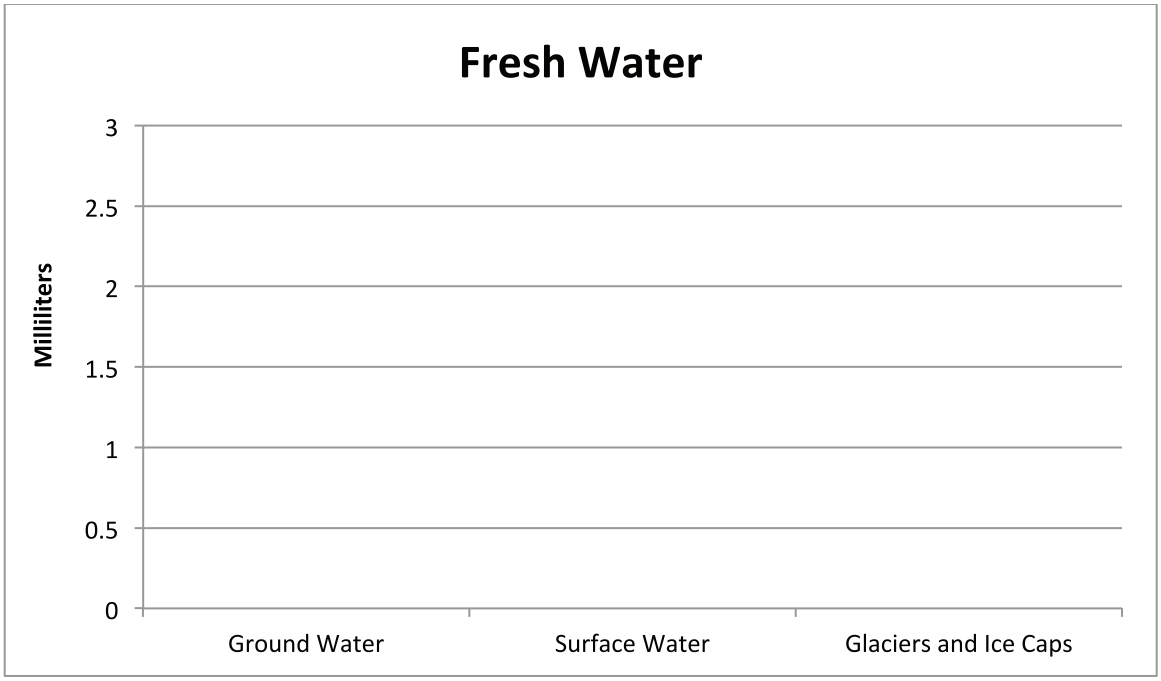
2. Convert 0.04 and 0.9 to fractions. Mark the approximate location for each fraction on the number line.



3. Draw a model that represents the amount of water in each graduated cylinder. Label each cylinder as ground water, surface water, or glaciers and ice caps. Indicate the water level in each graduated cylinder.



4. Use your diagram of the three 10 mL graduated cylinders to create a bar graph that represents the amount of water in each graduated cylinder.



5. Create a circle graph of the portion of fresh water that is ground water, surface water, and glaciers and ice caps. Label each sector with the name and fraction that each sector represents. Add a title to the graph. Round each answer to the nearest degree.

   a. Ground water:

   $$\frac{\text{\_\_\_\_ml of ground water}}{\text{3 ml of fresh water}} \times 360^o = \_\_\_\_\_\_\_\_\_\_\_\_$$

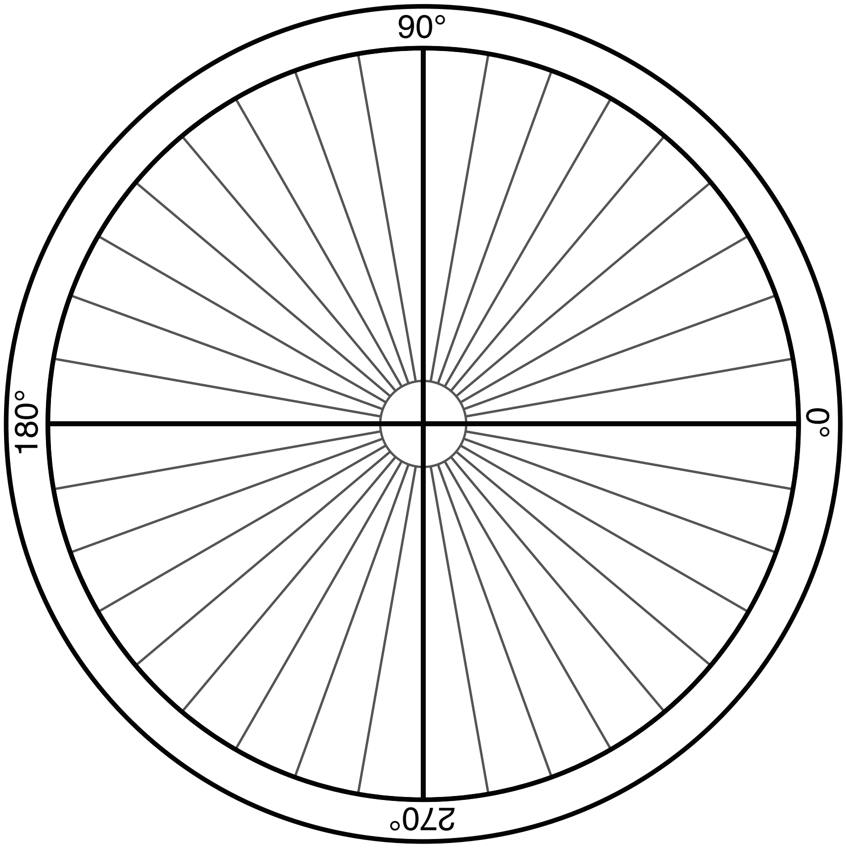
   b. Surface water:

   $$\frac{\text{\_\_\_\_ml of surface water}}{\text{3 ml of fresh water}} \times 360^o = \_\_\_\_\_\_\_\_\_\_\_\_$$

   c. Glaciers and ice caps:

   $$\frac{\text{\_\_\_\_ml of glacier and ice cap water}}{\text{3 ml of fresh water}} \times 360^o = \_\_\_\_\_\_\_\_\_\_\_\_$$

   d.



6. Where is most of the fresh water on Earth located?

7. Where is the least portion of the fresh water on Earth located?

8. Why is fresh water so important?

9. Name at least 5 ways that you can conserve water.

Activity 5: Down the Drain

As we saw in the previous activity, the amount of fresh water readily available for use is a very small percentage of all of the water on Earth. It is important that we conserve this very precious resource. Think for a moment of all the ways you use fresh water during the day. Of course we drink water, but what are some other ways that we use it?

Showering is one way that we use fresh water. In this activity you will go home and complete a survey with the help of others in your household.

- You will determine how many minutes, to the nearest minute, the water is running in the shower for each person who takes a shower.
- Encourage everyone to time how long they are actually in the shower as most people underestimate how much time they spend standing under the water.
- Once you determine how many minutes each person leaves the shower running, you will calculate how many gallons of water are used in each person's shower.
- Finally, you will calculate the total amount of water used for showers per day for your entire household.
- You will also examine how the type of showerhead (low flow or high flow) affects the amount of water consumed during a shower.

In order to determine how much water is used during a shower, you must multiply the minutes the person showers by the number of gallons of water that come out of the showerhead per minute.

- Let's try an example. Rachel takes a 15 minute shower each day. Her showerhead lets out $2\frac{1}{2}$ gallons of water per minute. How much water does Rachel use every time she showers? $15 \text{ minutes} \times \frac{2\frac{1}{2} \text{ gallons}}{\text{minute}} = \_\_\_\_\_\_\_\_$ Think about how many gallon jugs it would take to fill the tub! What if you had to carry those jugs?
- We can make some assumptions about the rate or amount of water that comes out of your home showerhead per minute or we can measure the flow.
  - Older shower heads (manufactured before 1994) have an average flow rate of about $\frac{5\frac{1}{2} \text{ gallons}}{\text{minute}}$.
  - Newer shower heads (manufactured after 1994) have an average flow rate $\frac{2\frac{1}{2} \text{ gallons}}{\text{minute}}$ as required by the Environmental Protection Agency (EPA).
- You can also, with permission of an adult in your household, measure the flow rate of your shower head.
  - Turn the shower on to the same pressure that you use during a shower.
  - Place a bucket that has a measurement for a gallon clearly marked under the showerhead.
  - Have someone time how many seconds it takes to collect a gallon of water.
  - Use the information to calculate how many gallons would flow in a minute.

Questions

1. Working with your team members, create a list of the ways you use fresh water each day.

2. How many gallons of water do you think you use when you take a shower?

3. Complete this chart at home with the help of household members. First have each person predict how many minutes they spend in the shower. Then use a stopwatch or timer to determine the number of minutes the water is running for each household member to take a shower. Remember to begin timing when the shower is first turned on, and stop timing when the water is turned off.

Household Member's Name	Predict the number of minutes spent in the shower	Actual number of minutes the water is running for a shower
Example: Ralph	10 minutes	15 minutes

4. Did any of the information surprise you or others at home?

5. Did anyone underestimate or overestimate the time that they actually spent in the shower?

6. Does the information in the chart tell you how much water is consumed by people taking showers at your home? What other piece of information do you need?

7. Using the flow rates for an older or newer showerhead or information that you obtained measuring the actual flow of your showerhead determine how many gallons of water are used in your house for showers. Complete the chart below:

Which shower flow rate does your shower have? _________________

Household Member's Name	Minutes the water is running in the shower	Shower flow rate in $\frac{\text{gallons}}{\text{minute}}$	Amount of water used in gallons
Totals			

8. Create a class line plot of the data for the “minutes the shower is running.” Work with your teacher and your class to create an appropriate scale for the line plot.

Number of Minutes the Shower is Running
Class Data

a. What is the maximum number of minutes that a person spends running water for a shower?

b. What is the difference between the maximum and minimum number of minutes that a person spends running the shower?

c. What is the most popular length of time to have the water running in the shower?

d. How many people spent more than 15 minutes running water in the shower?

9. Create a pictograph of the class data for how many gallons of water is used by each person for a shower (round the gallons to the nearest whole number). Work with your teacher and your class to create an appropriate range of the number of gallons. You may not need to use all the lines provided.

Number of Gallons	Number of household members
0 – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
_____ – _____ gallons	
Greater than _____ gallons	

10. Apply what you know to answer the following questions.
    a. How many household members used 30-45 gallons of water for their shower?

    b. Based upon the pictograph of the class data, the most number of people use how many gallons of water to take a shower?

    c. Maria likes to take a bath each night. She likes to fill the tub up and knows that each time she takes a bath she uses 30 gallons of water. Her mom says that she should take a shower to save water. Maria takes about 20 minutes in the shower using a shower head made in 2012. Is Maria's mother correct or incorrect? Why?

    d. Erica takes a 10 minute shower and Shannon takes a 22 minute shower using a shower head that uses 2½ gallons per minute. How much more water does Shannon use than Erica? Show your work.

    e. Did you realize how many gallons of water that you use when you take a shower?

11. John lives in a house that was built in 1976. All of the original fixtures (sinks, bathtubs, shower heads) are still in the house. John takes a 10 minute shower each day.

a. How much water does John use for each shower?

b. How much water does John use in a week?

c. How much water does John use in a year?

d. If John changed out the old shower head for a new shower head, determine how much water John would save in a day, a week, and a year.

	Amount of water used with old shower head	**Amount of water used with new shower head**	**Amount of water saved with new shower head**
Day			
Week			
Year			