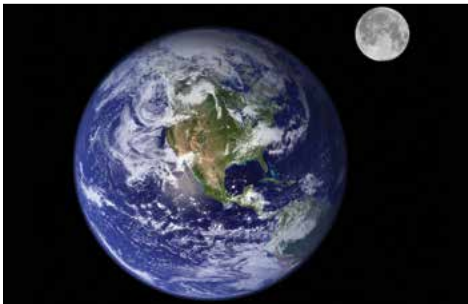
PHOTO CREDIT: © Hemera–Thinkstock Photos



Blue Planet

Why do we call our planet "Earth" when its surface is mostly water?

Grade Level
Pre-K through 2, Upper Elementary, Middle School, High School

Subject Areas
Earth Science, Geography, Math (statistics), Health (physical education)

Duration
Preparation time: Part I: 10 minutes; Part II: 5 minutes; Pre-K through 2: 5 minutes

Activity time: Part I: 30 minutes; Part II: 20 minutes; Pre-K through 2: 15-30 minutes

Setting
Indoor or outdoor

Skills
Gathering information (calculating); Organizing (plotting data, graphing, estimating); Analyzing; Interpreting; Applying (predicting)

Charting the Course
Following "Blue Planet," "A Drop in the Bucket" illustrates the amount of salt and fresh water on Earth. "The Life Box" illustrates the necessity of water for life. Students simulate the water cycle in "The Incredible Journey." "Aqua Bodies" demonstrates the amount of water in our bodies and in other animals and plants. "Is There Water on Zork?" investigates the properties of water.

Vocabulary
estimate, guess, percentage, probability, random sample, residence time, permafrost, potable, sample size

Summary
Students estimate the percentage of Earth's surface that is covered by water and, by tossing an inflatable globe, take a simple probability sample to check their estimates.

Objectives
Students will:
- estimate the percentage of Earth's surface that is covered by water.
- predict what a probability sample will reveal about the relative coverage of land and water.
- estimate how long water remains in locations such as rivers, lakes, ground water and the ocean.

Materials
Warm Up
- *Two sets of colored beads or paper squares (71 blue beads or squares and 29 tan)*
- *Large plastic bag*
- *Four chenille twists*
- *Calculator*
- *Copies of* ***Blue Planet—Do the Math!*** (one per student)

Part I
- *Inflatable beach-ball globe that shows water and land masses or classroom globe*
- *Whiteboard, chalkboard or flip chart*
- *Pencil and notepad*
- *Calculator*

Part II
- *Whiteboard, chalkboard or flip chart*
- *Notepaper and pencil* (per group of three to four)

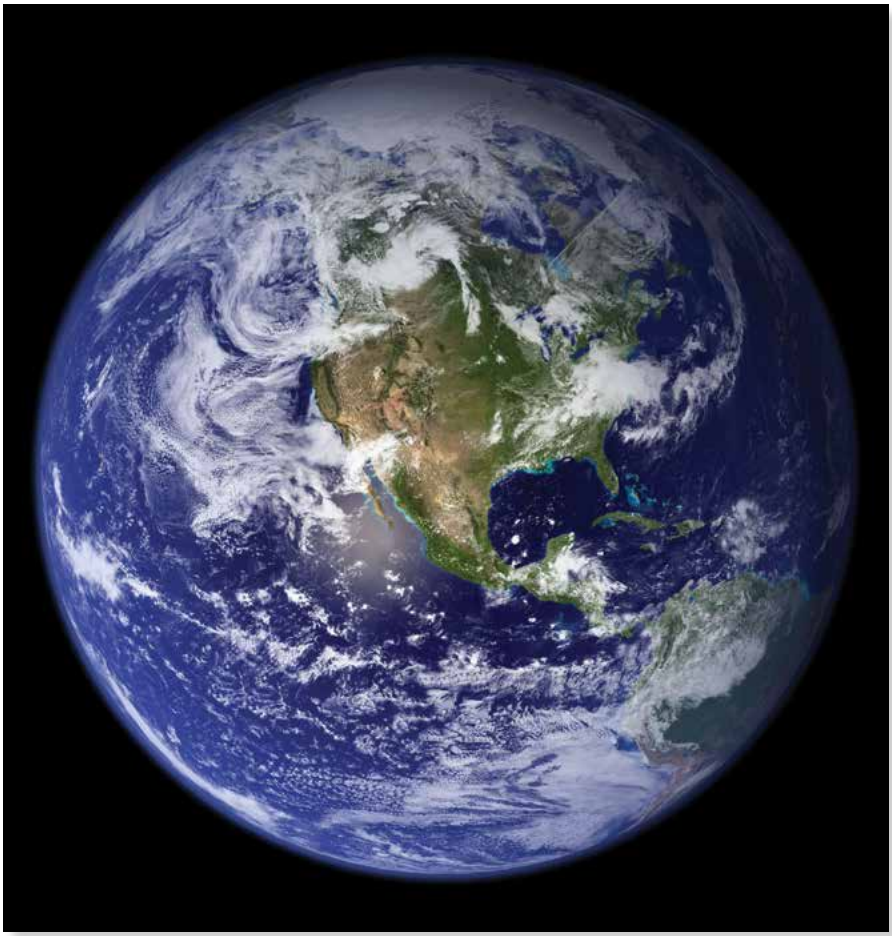
Pre-K through 2 Activity
- *Inflatable beach-ball globe that shows water and land masses or classroom globe*
- *Whiteboard, chalkboard or flip chart*
- *Copies of* ***Planet Paint*** (one per student)

Making Connections
Students recognize that the planet is made up of both land and water. However, they may not have considered how much of Earth is covered with water, the residence time of water in different places, the amount of potable (drinkable) water and the unequal distribution of water on Earth. Understanding these concepts, students should develop a greater appreciation for protecting water quality and quantity.

Background
Dramatic views of Earth from space have confirmed what global mapping has shown for well over a century: the majority of Earth's surface is covered by water. Cartographers and geographers have mapped and measured the surface of Earth and have determined the approximate areas as follows:

Land area = 148,429,000 sq. kmWater area = 361,637,000 sq. km

Source: *National Geographic Atlas of the World*



Our blue planet as seen from space

PHOTO CREDIT: © NASA Goddard Space Flight Center Image

The total surface area of Earth is the sum of the land area and water area (510,066,000 sq. km). By dividing the water area by the total surface area, we can calculate the percentage of Earth's surface that is covered by water: 361,367,000 ÷ 510,066,000 = 0.7085, which we can round to 0.71, or 71 percent.

Since we know by measurement that approximately 71 percent of Earth's surface is covered by water, the mathematical concept of probability allows us to predict what will happen when we randomly select locations on a globe.

Probability is the same concept as selecting heads or tails for a coin toss. If you toss a coin into the air, there is a one in two (or 50 percent) probability the coin will land heads up. If you toss the coin 10 times, there is the same probability the coin will land heads up five times, and tails up five times, even though the actual result may not have these exact numbers. The probability remains the same.

This same concept holds true for water locations on a globe. In theory, a random sampling of 100 points on an accurate globe would yield 71 points on water and 29 points on land. Smaller samples should yield similar ratios. For example, a random sampling of 40 points on our globe should return approximately 28 points that are water, or 70 percent. The number of samples, or the sample size, is important. For our purposes, a sample size of 30 or more is needed to return a reasonably good statistical result. As you might expect, the larger the sample size, the more accurate the results obtained.

Probability is a powerful tool when we don't know the expected results. For example, if we didn't know by scientific measurement that 71 percent of Earth's surface is covered by water, probability theory would allow us to take a random sample of points on the globe's surface and apply our findings to the entire surface of the globe. (See the example in the ***Warm Up*** below.)

In this activity, students will use the power of probability and a random sample of points on the globe's surface to determine if their results coincide with what they know, or think they know, about the proportion of land to water on Earth's surface.

Procedure

▼ *Warm Up*

- Show students the beads or paper squares in a clear plastic bag.
- Tell students their task is to statistically sample the beads or squares to predict what percentage of them are blue. (Another way of saying this: They will determine the probability of selecting a blue bead or square.)
- Shake the beads or squares so they are randomly distributed in the bag.
- Have a student, without looking at the bag, randomly remove a single bead or square. Always have students return the bead or square to the bag after they report its color and be sure to shake the bag before drawing another bead or square.
- Using a second supply of beads, have two students record the results by placing the beads on chenille twists. Have one student place only blue beads on a chenille twist; have the other student place tan beads on another twist. This represents the data in a graph-like format. If you are using squares, have students create two bar graphs on the board: blue squares and tan squares.

- After a total of 30 beads or squares have been selected from the bag, stop and have students calculate the percentage of blue beads or squares selected compared to the other color. To calculate the percentage, divide the number of blue beads or squares by the total number of beads selected (30) and convert the decimal into a percentage (multiply by 100).
- Repeat the procedure. After the colors of the second 30 beads have been recorded, divide the total number of blue beads from both samples by 60 (the total number of beads sampled) and convert your answer to a percentage. Your percentage of blue beads should be close to 71 percent. If your percentage differs slightly from 71 percent, it is okay. Statistical sampling allows for a margin of error. However, if your sample differs significantly, you may want to continue sampling.
- Even though you've only sampled 60 of the beads, probability allows you to be fairly certain that when all the beads are counted, approximately the same percentage as your sample will be blue.
- Finally, have students count all the beads. They should find 71 are blue and 29 are tan, which turns out to be 71 percent blue beads (71 divided by 100).
- In the activity, we'll apply our sampling skills to Earth's surface.

▼ *The Activity*

Part I

1. **Ask students if they believe the concept of probability tested in the *Warm Up* is correct.** If not, discuss ideas such as batting averages, free-throw percentages or other common probabilities.
2. **Show students an inflated beach-ball globe or classroom globe and ask:**
   - What does this represent?
   - What colors do you see? What do the different colors represent?
   - Why do you think some people call Earth the blue planet? (The answer is not that water is blue, but that most of Earth's surface is covered by water, which appears blue.)
   - What percentage of Earth's surface do you estimate is covered by water? (Record your answer in a pie chart on the **Student Copy Page**. Post answers on the chalkboard or flip chart.)
   - Are you guessing or do you know the percentage is a fact? If you know it's a fact, how do you know? Did someone tell you? Did you read it in a book or research it on the Internet?
   - Is water evenly distributed across Earth? (No, because it is separated by continents and other landforms. Many factors contribute to water's uneven distribution on Earth, such as: climate [related to the latitude of a region], landforms, soil, geography, seasonal precipitation.)
   - Have students stand and form a circle facing toward the center while you stand in the center.
3. **Say to students: We are going to randomly sample Earth's surface by tossing and catching the beach ball.** Each time the ball is caught, we will record whether the tip of the catcher's left thumb is on land or water.
4. **Remind the students of their estimates. Choose an estimate from the recorded list.** Ask: If this estimate is close to accurate, what do you expect will happen when we toss and catch the beach ball? (Example: If the estimate is 60 percent water, we'll expect that approximately six of every 10 tosses of the ball will be caught with the tip of the left thumb on water. In other words, the probability of touching water is 0.60 or 60 percent.)
5. **Establish rules for tossing the beach ball.** Students may toss the ball to each other or may toss it to you in the center and you then toss it to each student.
6. **After each catch, the person who caught the ball announces whether the tip of his or her left thumb is on land or water.** If the tip of the thumb is touching both land and water, the student should choose the one it seems to be touching more. Remember that the ice cap in the Arctic (at the North Pole) is all water, while the continent of Antarctica is under much of the ice cap at the South Pole. Ask students: If your thumb lands on Antartica, should you choose land or water? (If the thumb lands on Antarctica, it should be counted as land.)
7. **Record each catch under headings titled "land" or "water" on a notepad, chalkboard or flip chart.** Another option is to assign two students to be recorders. Each student holds one chenille twist. The "land" student places a tan bead on the chenille twist each time a student announces land. The "water" student places a blue bead on his or her twist each time water is called.
8. **Toss the ball around the group until you have at least 30 sample points and each person in the group has caught the ball.**
9. **Ask students to return to their seats. Have them look at the tally.** Ask them to write a ratio expressing the relationship of the number of water catches to the total number of catches. Then have the students convert that ratio into a percentage. (Example: Land = 12, Water = 28, Total = 40. Water ratio = 28/40. Percentage of water is 28 divided by 40 or 70 percent.)
10. **If you do not have a beach-ball globe, you can use a classroom globe and have students sit and pass it from one student to the next.**
11. **Compare the sample percentage with students' estimates and predictions.** Were they close? Tell students that scientists and

geographers have measured Earth's surface and have calculated that approximately 71 percent is covered by water. How did their sample compare to the scientists' measurements? If their sample differs greatly from 71 percent, can they determine why? What might they do differently? Would more tosses move the sample percentage closer to 71 percent? Try it.

12. **Have students create a pie chart showing the percentage of water and land on Earth.**
13. **Show students views of Earth from space.** Ask them again if they believe Earth is accurately called the blue planet. (The NASA website has excellent images.) Have students produce a digital presentation illustrating the blue planet.

Part II

1. **Ask students if water exists in other locations besides on Earth's surface.** (Ground water, soil water, atmosphere) How does a drop of water get into these various locations? (Precipitation, evaporation, surface water runoff, ground water recharge) Ask if they have any ideas how long a drop of water remains in a river, lake or reservoir, soil, ground water, ocean or sea, ice cap or glacier, the atmosphere. Ask them to consider what would cause a drop of water to remain in one of these locations longer than in another. For example, would they expect that water would remain longer in a river or in a glacier? What are the forces that affect how long a molecule of water remains in a location? (Solar energy, gravity, atmospheric pressure) Record their ideas on a board or chart.
2. **Divide students into groups of three to four.** Have them discuss the results listed on the board, and rank these seven categories listed in step 1 from the longest time a drop of water could remain in that location (called residence time) to the shortest time. Tell students that residence times range from 10 days to 10,000 years. Have one student in each group serve as a recorder. Have the groups prepare several reasons why they selected their particular ranking.
3. **Bring the groups together and have the student recorders report their results to the class.** Record the answers on a whiteboard or poster.
4. **Discuss the differences between the rankings, and ask the groups why they selected their ranking order.** Ask other groups if they would like to change their previous rankings.

The residence time of a water molecule in a glacier is estimated to be 1,000 to 10,000 years.

PHOTO CREDIT: © Hemera–Thinkstock Photos

5. **Have the groups vote on the final order for their prediction of residence time for water molecules found in different locations.**
6. **Show the class the following results and remind them that these figures are approximations:**

Oceans and seas	4,000 years
Ground water	2 weeks to 10,000 years
Lakes and reservoirs	10 years
Icecaps, glaciers and permafrosts	1,000 to 10,000 years
Soil moisture	2 weeks to 1 year
Rivers	2 weeks
Atmospheric water	10 days

Source: Igor A. Shilomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris, 1999; Max Planck, Institute for Meteorology, Hamburg, 1994; Freeze, Allen, John, Cherry, *Groundwater*, Prentice-Hall: Englewood Cliffs NJ, 1979.

7. **Remind students that there are vast differences among water systems.** Water may move very quickly as ground water or may remain underground for thousands of years, such as the fossil water of Nebraska's Ogallala Aquifer. Through the water cycle, water is constantly on the move. However, under the right conditions, it is possible for water to be "locked up" (e.g., in glaciers, ground water, the ocean).
8. **Ask students why scientists would be unable to give exact time frames for the residence time of water in various locations.** What would cause one molecule of water to remain in a glacier for 10 years and another molecule of water to remain in a different glacier for 10,000 years? (Varying climate, solar energy differences) Are there several ways these results could be ranked from longest to shortest residence time? (Yes)

Wrap Up

- Ask students again: Why do some people call Earth the blue planet? How would they feel if Earth was called Water?
- Ask them to guess why Earth is used as the name for our planet. (Although all of the other planets were named after Greek and Roman gods and goddesses, *"earth"* is an English/German word that means "ground.")
- Ask students what they would name our planet.

Project WET Reading Corner

Carlisle, Madelyn. 1992. *Let's Investigate Marvelously Meaningful Maps*. Hauppauge, NY: Barrons Juveniles.*

Learn how to read a map, including how to read symbols, scale, topography and so forth.

Dorros, Arthur. 1993. *Follow the Water from Brook to Ocean.* Madison, WI: Demco Media.* +

Two young children follow rain water to a brook and on to the ocean.

Eales, Philip. 2007. *Map: Satellite*. New York, NY: Dorling Kindersley, Inc.

Gathered together in a single book are satellite images from all over the world showing arctic ice, ozone depletion, seasonal changes and natural and man-made features.

Hooper, Meredith. 2008. *A Drop in My Drink: A Story of Water on Our Planet.* London, UK: Francis Lincoln Children's Books.

The story of a single drop of water is followed through eons of earth's history.

Locker, Thomas. 2002. *Water Dance.* San Diego, CA: Voyager Books/Harcourt.

Travel from a mountain pond to a raging waterfall and from an ocean mist to a sparkling rainbow. Dramatic haiku-like text and lush paintings give water voice and substance in this tribute to water and the water cycle. There is a companion teacher resource.

McKinney, Barbara Shaw. 1998. *A Drop Around the World.* Nevada City, CA: Dawn Publications.+

A journey with a raindrop as it touches all life-forms as a solid, liquid and vapor from Maine to Mumbai. Also see *A Teacher's Guide to a Drop Around the World* for lesson ideas.

Project WET Foundation. 2008. *Water is Life*. Bozeman, MT: Project WET Foundation.+

Colorful illustrations show the water cycle and how water is important to humans and animals alike on the African continent.

Relf, Pat. 1996. *The Magic School Bus: Wet All Over.* New York, NY: Scholastic Press.+

Students go on an adventure in the Magic School Bus to learn about the water cycle.

Strauss, Rochelle. 2007. *One Well: The Story of Water on Earth*. Tonawanda, NY: Kids Can Press Ltd.

A broad look at water today and how the earth can literally be one well from which we all draw the water we need to survive.

Sussman, Art. 2000. *Dr. Art's Guide to Planet Earth: For Earthlings Ages 12 to 120.* White River Junction, VT: Chelsea Green.

Highly acclaimed book examines matter cycles, energy flows, and life webs and how all are connected on planet Earth.

*National Governors Association Center for Best Practices and Council of Chief State School Officers. "Texts Illustrating the Complexity, Quality, and Range of Student Reading K-5" and "Texts Illustrating the Complexity, Quality, and Range of Student Reading 6-12." Common Core State Standards Initiative. www.corestandards.org/ (June, 2009).

+Reading materials for Pre K-2 Activity.

Assessment

Have students:

- draw a pie chart illustrating their estimate of the amount of water and land on Earth (***Part I***, step 12).
- draw a pie chart representing 71 percent of Earth's surface as water and 29 percent as land and compare to their estimate (***Part I***, step 12).
- produce a digital slideshow of images reinforcing the idea of Earth as the blue planet (***Part II***, step 13).
- estimate how long water remains in locations such as rivers, lakes, ground water and the ocean and compare with other groups to determine best estimates (***Part II***, steps 1-6).

Extensions

Have students research Water Distribution and Availability maps and predict our water future. Have them discuss ongoing research to provide plentiful, clean water for all people who need it, now and into the future.

Pre-K through 2 Activity Objectives

Students will:

- identify land and water areas on a globe.
- determine that water covers the greater area of Earth.

Procedure

▼ *Warm Up*

- Show students the beach-ball globe or classroom globe. Ask them what it is.
- Tell them that it is like a picture of Earth where all people, plants and animals live.
- Ask them what they think the green color is? The blue? Write the words "land" and "water" on the board.
- Ask them if they think there is more water or land on Earth.

▼ *The Activity*

1. **Have students sit in a large circle on the floor with the teacher in the middle.** The teacher should roll the globe-ball to each student. Have the student stop the ball with one finger. Ask them if their finger is on blue or green. Have an aide record the result on the board. Have the student roll the ball back to the teacher in the center.
2. **Once you have rolled the ball 30 times, have the aide total the count.** Ask students again if they think there is more water or land on Earth. Compare their answers to the tally.
3. **Ask why some people call Earth the blue planet.** We may call our planet Earth, but it is mostly water.

▼ *Wrap Up*

Have students color the **Student Copy Page, *Planet Paint***. Remind them that all land should be green and all water blue. Ask them if there are areas that should be colored blue on the land. What do those areas represent? (Lakes, rivers, ponds) Ask them to predict what color will cover most of the picture.

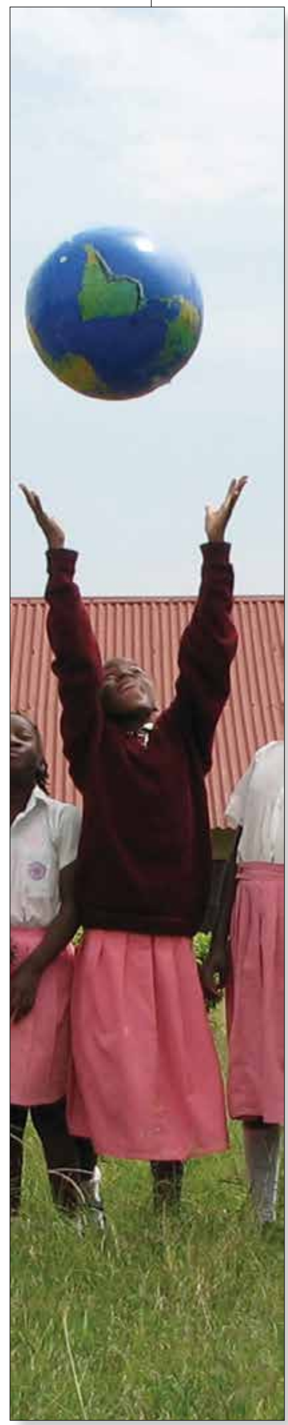


PHOTO CREDIT: © Project WET Foundation

A student in Uganda participates in the Blue Planet activity.

Teacher Resources

Books

Gleick, Peter, el al. 2009. *The World's Water: The Biennial Report on Freshwater Resources*, 2008-2009. Washington, DC: The Island Press.

National Geographic Society. 2010. *National Geographic Atlas of the World.* 9th ed. Washington, DC: National Geographic Society.

Strahler, Alan H. 2010. *Introducing Physical Geography*. 5th ed. New York, NY: John Wiley and Sons, Inc.

Journals

Hrennikoff, Margo. 2006. "Implementing an Imaginative Unit: Wonders of the Water Cycle." *Educational Perspectives*, 39 (2), 27-33.

Toft, Joanne and Kathy Scoggin. 2007. "The Ripple Effect." *Science and Children*, 45 (3), 21-23.

Vowell, Julie and Marianne Phillips. 2007. "A Drop through Time." *Science and Children*, 44 (9), 30-34.

Websites

National Aeronautics and Space Administration (NASA). Students may search NASA images for the Blue Planet. www.nasa.gov. Accessed December 6, 2010.

National Center for Educational Statistics (NCES). A fun website where students design their own graphs. http://nces.ed.gov/nceskids/index.asp. Accessed December 6, 2010.

Warm Up

First Draw of Beads (30)

1. The total number of beads withdrawn is 30.

2. The total number of blue beads withdrawn is ____________

3. Divide:

Number of blue beads withdrawn ÷ 30 = ____________ (this will be in the form of a decimal)

4. Multiply:

(decimal from #3) X 100 = ____________ % (percentage of blue beads withdrawn)

Second Draw of Beads (30)

5. First Draw (30 beads) + Second Draw (30 beads) = 60 beads total

6. First Draw (# of blue beads) + Second Draw (# of blue beads) = ____________ (total blue beads)

7. Divide:

Total blue beads ÷ 60 beads = ____________ (this will be in the form of a decimal)

8. Multiply:

(decimal from #7) X 100 = ____________ % (percentage of blue beads withdrawn)

9. Is your percentage of blue beads close to 71%?

10. If your percentage differs a lot from 71%, what could you do? (A larger sample size?)

11. Count all of the beads:

How many blue beads? ____________ tan beads? ____________

So, in the actual sample what was the percentage of blue beads and tan beads?

# of blue beads counted ÷ total number of beads = decimal X 100 = ____________ % blue beads

# of tan beads counted ÷ total number of beads = decimal X 100 = ____________ % tan beads

Part I

1. Draw a pie chart showing how much of Earth you think is water and land. You can have fun creating a graph on several websites for example, http://nces.ed.gov/nceskids/createagraph/.

2. Write a ratio expressing the # of water catches to the total # of catches.

3. Calculate the following:

# of water catches ÷ total number of catches = ____________ (decimal) X 100 = ____________ %

4. Scientists and geographers have measured Earth's surface and have calculated that about 71% is covered by water.

Land area (148,429,000 sq. km) + Water area (361,637,000 sq. km) = 510,066,000 sq. km, Earth's total surface area

Based on these figures, calculate Earth's water area:

361,637,000 ÷ 510,066,000 = ____________ (decimal) X 100 = ____________ % water area

5. Create a pie chart showing the correct percentages of land and water on Earth. How does it compare with the one below created on the KIDS' Zone of the National Center for Educational Statistics, http://nces.ed.gov/nceskids/index.asp?

Write the percentages for land and water under the blue and green squares.