Investigating Water Behavior

Students will continue to develop a range of skills to achieve greater understanding of the scientific method, scientific inquiry and the nature of science, as well as more fully grasp physical science and the nature of water.

Audience

- Middle School Science (6-8)

Strand

- Scientific Method/Scientific Inquiry

Topic

- Investigating Water Behavior

Key Concepts/Background Information

- Water has many unique and important properties and can be used to demonstrate other key chemical and physical processes. By understanding these properties, we can better understand our natural and living environment. Students will learn key parts of the scientific method by investigating water behavior.

VA SOL Standards

- ***PS.1*** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
  - a) chemicals and equipment are used safely;
  - b) length, mass, volume, density, temperature, weight, and force are accurately measured;
  - d) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, probeware, and spring scales are used to gather data;
  - f) independent and dependent variables, constants, controls, and repeated trials are identified;
  - g) data tables showing the independent and dependent variables, derived quantities, and the number of trials are constructed and interpreted;
  - j) valid conclusions are made after analyzing data;
  - k) research methods are used to investigate practical problems and questions;
  - l) experimental results are presented in appropriate written form;

- ***LS.1*** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
  - a) data are organized into tables showing repeated trials and means;
  - c) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, and probeware are used to gather data;
  - e) sources of experimental error are identified;
  - f) dependent variables, independent variables, and constants are identified;
  - g) variables are controlled to test hypotheses, and trials are repeated;
  - h) data are organized, communicated through graphical representation, interpreted, and used to make predictions;
  - i) patterns are identified in data and are interpreted and evaluated; and

- ***ES.1*** The student will plan and conduct investigations in which
  a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;
  b) technologies, including computers, probeware, and geospatial technologies, are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;
  c) scales, diagrams, charts, graphs, tables, imagery, models, and profiles are constructed and interpreted;
  e) variables are manipulated with repeated trials;

- ***ES.2*** The student will demonstrate an understanding of the nature of science and scientific reasoning and logic. Key concepts includes
  b) evidence is required to evaluate hypotheses and explanations;
  c) observation and logic are essential for reaching a conclusion; and

Learning Objectives

- Describe science as being a process of proposing and testing hypotheses.
- Distinguish between statements that are testable by science and those that are not.
- Describe the meaning and purpose of experimental variables: control, independent and dependent
- Write a testable hypothesis.
- Gather data from an experiment and analyze the data.
- Complete a conclusion or summary.
- Design an experiment to test a hypothesis.

Essential Questions

- How do we conduct scientific investigations?
- How do we conduct a fair test?
- How do we design effective experiments?
- How do we gather, analyze, and communicate data from an experiment?

Students will be able to explain, interpret, and apply the following:

- *Key Vocabulary:* hydrophilic, hydrophobic, hypothesis, data, observations, independent variable, dependent variable, constants, controls, conclusion, results, repeated trials, nanotechnology.
- To communicate the plan of an experiment accurately, the independent variable, dependent variable, and constants must be explicitly defined.
- The number of repeated trials needs to be considered in the context of the investigation. Often "controls" are used to establish a standard for comparing the results of manipulating the independent variable. Controls receive no experimental treatment. However, not all experiments have a control.
- The analysis of data from a systematic investigation may provide the researcher with a basis to reach a reasonable conclusion. Conclusions should not go beyond the evidence that supports them.
- Different kinds of problems and questions require differing approaches and research. Scientific methodology almost always begins with a question, is based on observation and evidence, and requires logic and reasoning. Not all systematic investigations are experimental.

- It is important to communicate systematically the design and results of an investigation so that questions, procedures, tools, results, and conclusions can be understood and replicated.
- Some useful applications of physical science concepts are in the area of materials science (e.g., metals, ceramics, and semiconductors).
- Nanotechnology is the study of materials at the molecular (atomic) scale. Items at this scale are so small they are no longer visible with the naked eye.
- New discoveries based on nanoscience investigations have allowed the production of superior new materials with improved properties (e.g., computers, cell phones).

ENGAGE/DEMONSTRATION
Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Gather students in a group. Ask students to observe what happens to two types of sand (Magic Sand and Regular Sand) when poured in a beaker of regular tap water. We are to introduce the idea that different substances react in a uncharacteristically way.

Materials for the Demonstration

- Magic Sand "http://www.stevespanglerscience.com/magic-sand.html"
- Regular Sand
- Food Coloring (optional)
- Water
- 2 graduated cylinders
- 2 1000 ml beakers

Teacher Preparation

Pour 800 ml of water into each beaker and pour 100 ml of Magic Sand and Regular Sand into the graduated cylinders.

Procedure

1. Tell students that you have two types of sand in each graduated cylinder. Both look alike, but they are chemically different. (Note: Magic Sand can be made or purchased in different colors)
2. Pour 100 mL of the sand into each beaker. Observe
3. Pick the sand in and out of the water. Observe.

Expected Results

The magic sand stays dry and does not stick to your hand as much. The regular sand sticks to your hand and is extremely wet.

Ask Students:

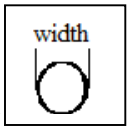
1. Ask students to describe what happened to the sand and water. Encourage students to talk about the settling of the sand in the beaker.
2. Both sands looked similar at first. How do you know that they are different?
2. What makes them different?
3. What is the meaning of the terms hydro, hydrophilic and hydrophobic?

Teacher Preparation for Student Laboratory Activities

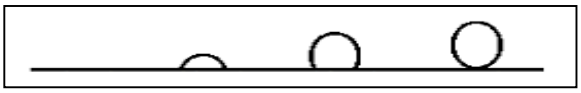
Part A: Investigating Water Drop Shapes

Purpose: Variables are an important part of science projects and experiments. After completing this activity, students will have a better understanding of independent, dependent and control variables by studying the water drop shapes on different surfaces.

Part B: Investigating the Width of a Water Drop

Purpose: Students will develop a hypothesis and inquirer if the width 

of water drops have a relationship to the shape of the water drops.



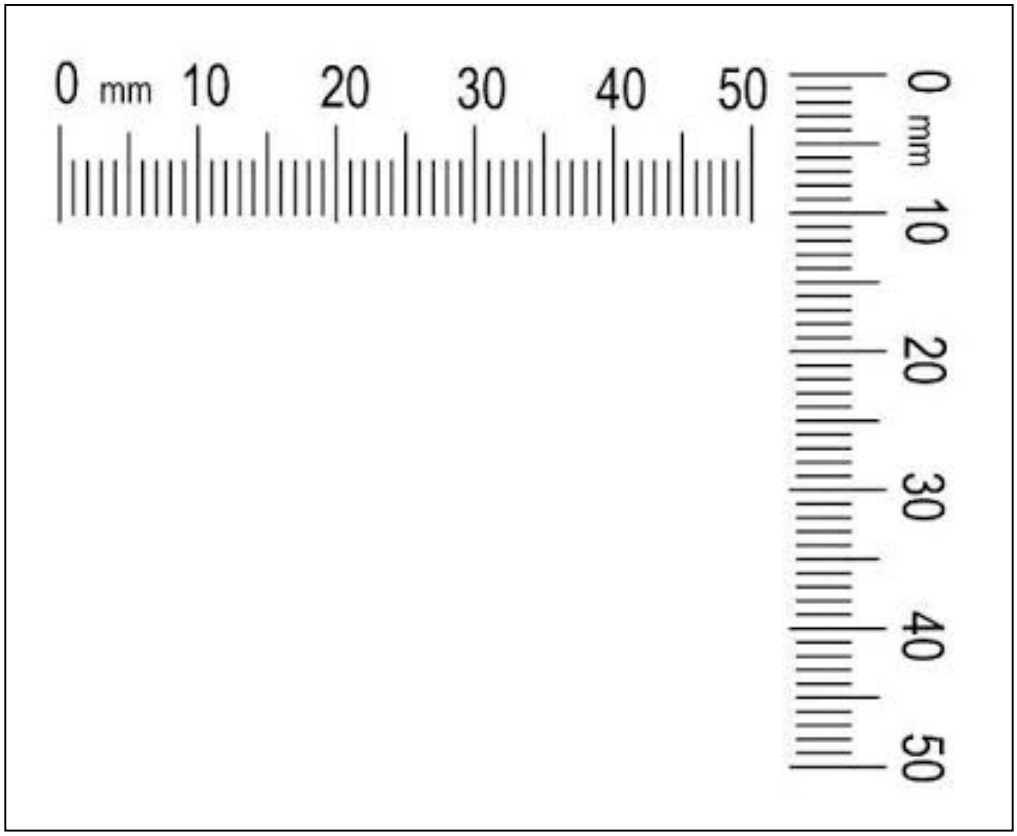
Part C: Expanding an Experiment

Purpose: Students will design an experiment using the techniques and materials from Part A and Part B. In order for students to be successful, make sure students have access to different types of material that can be found in a typical science classroom. For example, students can test the water drop shapes on the different materials that are contained in a density cube set or students can test if different liquids make a different water drop shape on the same surface.

Equipment:

- **3 to 5 Pre-treated microscope slides**
  [Pre-treat 3 to 5 glass slides for each team using Rain-X® Original Glass Treatment, Thompson's® WaterSeal® Clear Multi-Surface Water proofer, 3M™ Glass Cleaner and Protector with Scotchgard and (OTS) octadecyltrichlorosilane superhydrophobic coating or Liquid Diamond Shield hydrophobic glass protectant] Note: The OTS slides were made in the Pesika Laboratory at the Department of Chemical and Biochemical Engineering at Tulane University, New Orleans, LA 70118 all others materials can be purchased at your nearest hardware store.
- **Food color** *(add to water for visual enhancement)*
- **250 to 500 ml Beaker**
- **3ml Pipette**
- **Pasco USB Camera/Microscope or magnifying glass**

Note: (Part B: Investigating the Width of a Water Drop) If students do not have access to a digital microscope or camera with measuring capabilities, have the students place the slides on top of the rulers to obtain a proper measurement.



Example:

Assessment

- **Other**
  - Give a quiz on experimental design to assess students' abilities to label the control, dependent and independent variables.
  - Assess measurement and data organization skills through lab work and the related data tables and activity questions.
  - Give a lab practical covering measurement to help assess skill level and laboratory competency.

Strategies for Differentiation

- Model how to design an experiment to include research question hypothesis, independent and dependent variables, constants and controls and a sample data table.
- Have the student present findings of Part D using electronic presentation software.
- Have each student write a short description of another group's experiment (Part D), using academic language and key vocabulary. Have students share their descriptions orally with the class.
- Have students use visual picture communication systems to create a graphic organizer of experimental design.
- Have students use software to create a flow chart to organize the steps in the procedure.

References

http://www.stevespanglerscience.com/magic-sand.html

http://www.nnin.org/education-training/k-12-teachers/nanotechnology-curriculum-materials/exploring-properties-magic-sand

Yuan, Yuehua and T. Randall Lee. "Contact Angle and Wetting Properties." *Surface Science Techniques*. Heidelberg: Springer, 2013. 3-34. Print.

Cremaldi, Joseph, David Cutting, Kristen Wollman, and Noshir Pesika. "*Interfacial Interactions between Oil and Surfaces.*" Department of Chemical and Biochemical Engineering, Tulane University, New Orleans, LA 70118

http://www.nnin.org/education-training/k-12-teachers/nanotechnology-curriculum-materials/water-race-hydrophobic-0

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Name:_____ **Date:**_____

Part A: Investigating the Shape of Water Drops

Introduction: The way water interacts with the surface of an object can have important consequences. In this lab, you will learn more about different surface coatings and their uses.

Define:

- Hydrophilic

- Hydrophobic

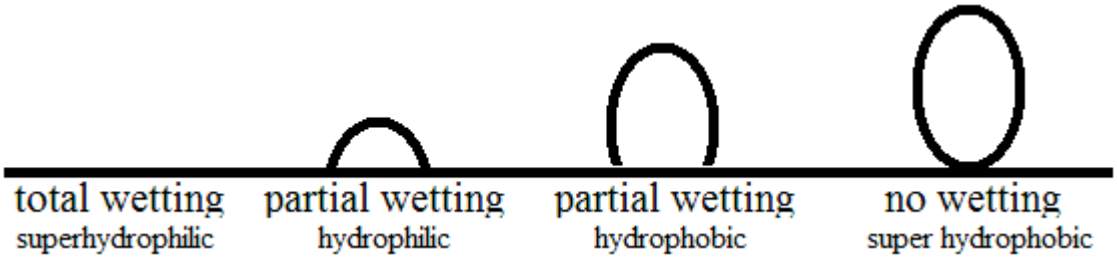
Equipment:

3 - 5 Pre-treated microscope slides
250 mL Beaker
3 ml Pipette
Pasco USB Camera Microscope or magnifying glass

A. Observing Surface Coatings

Introduction

Your teacher will provide you with up to five glass microscope slides labeled A-E. One of these slides is plain glass, and the rest have been treated with a variety of glass treatments to change the surface properties. In this part of the lab, you will observe how water acts differently on each of these surfaces.



Procedure

1. On each glass slide, place a drop of water using the pipette. Look at the shape the water drops takes on the glass slides. In the data table below, describe or carefully sketch what they look like.

2. Next, pick up each slide (with a water droplet) and tilt them from side to side. How does the water behave on each slide?

3. Using your observations from 1-3 and the diagram above, determine if the surface of each glass slide is hydrophilic or hydrophobic.

Results/Observations

Slides	Water Drop Shape	Behavior of Drop When Tilted	Type of Surface (Hydrophilic or Hydrophobic)
A			
B			
C			
D			
E			

4. Which slide is the most hydrophilic?

5. Which slide is the most hydrophobic?

6. Identify the independent variable.

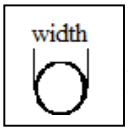
7. Identify the dependent variable.

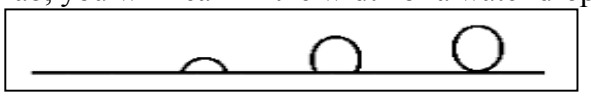
8. Identify the control variable.

Discussion/Summary

Name:_____ **Date:**_____

Part B: Investigating the Width of a Water Drop

Introduction: In this lab, you will learn if the width of a water drops 

have a relationship to the shape of the water drop. 

Hypothesis/Prediction/(Educated Guess):

If_____

then_____

Equipment:

Pasco USB Camera Microscope or magnifying glass
3 – 5 Pre-treated microscope slides
250 Beaker
3 ml Pipette

Procedure

1. On each glass slide, place a drop of water using the pipette. Measure the width of the water drop using the digital microscope.

Slide	A	B	C	D	E
Width (mm)					

2. Which water drop (slide) has the longest width?

3. Which water drop (slide) has the shortest width?

4. Compare your observations for Part A and for Part B. Do you notice a relationship between the WATER DROP SHAPE and the WATER DROP WIDTH in Part A and in Part B? If yes, state the relationship below.

5. Was your prediction correct? If not, provide 2-3 reasons the experiment may have come out differently than you had expected.

1.

2.

3.

Discussion/Summary

Name:_____ **Date:**_____

Part C: "Expanding an Experiment"

INTRODUCTION: In this activity, you will design an experiment to help you prepare for the science fair in January. Designing an experiment is making an organized plan to test a hypothesis. An experimental design usually follows a definite pattern. When you design experiments according to this pattern, you will use many individual science skills we have learned. Some of these skills are described briefly below.

1. **Identify the Problem:**
2. **Form a Hypothesis:**
3. **Materials List:**
4. **Experimental Procedure/Plan:**
5. **Recording and Analyzing Data:**
6. **Summary or Conclusion:**

THINK ABOUT IT: Experiments involve changing something to see what happens. Review the experiments you just performed. How is each part different from one another? How can you continue this experiment? What factors can we change to expand this experiment? What can you change to continue the experiment using materials in the classroom?

DIRECTIONS: Choose a problem you and your group would like to solve. Alternatively, pose a scientific question and obtain your teacher's approval to use that question. Remember, as a group you are expanding on the last two activities completed. Then write a hypothesis and design an experiment to answer the question. Be sure to include all the necessary parts of an experiment, such as naming the manipulated and responding variables and identifying the variables you will control. Include a data table you could use for recording your observations. Use the back of this sheet or a separate sheet of paper for your work.