

Academy of Our Lady Lesson Plan

Week of _____ Unit Contact Angles and Wetting Teacher Genia Roper Course Physical Science Honors

Standards

- Write a testable question or hypothesis when given a topic (SI-H-A1)
- Plan and record step-by-step procedure for a valid investigation, select equipment and materials, and identify variables and controls (SI-H-A2)
- Conduct an investigation that includes multiple trials and record, organize and display data appropriately (SI-H-A2)
- Analyze the conclusion from an investigation by using data to determine its validity (SI-H-B4)
- Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. (HS-PS1-3)
- Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. (HS-PS2-6)
- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants (HS-ETS1-1)
- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural and environmental impacts. (HS-ETS1-3)
- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (HS-PS-4)
- Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject demonstrating understanding of the subject under investigation (HS-PS-3-3), (HS-PS 3-4), (HS-PS 3-5)

Essential Questions

- What makes water stick to itself and form bubbles and droplets?
 - Why do water droplets stick to things?
- What causes water to be absorbed by a paper towel or move up a capillary tube?

Content

- Hydrophobic vs. Hydrophilic
- Wetting and Contact Angles

Content

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- Hydrophobic vs. Hydrophilic
- Wetting and Contact Angles

Skills

- **Explore** the properties of molecular bonding.
- **Demonstrate** the concepts of hydrophobic and hydrophilic behavior.

Skills

- **Describe** and **predict** the behavior of water and hydrophilic and hydrophobic surfaces and explain in general terms what causes the difference in behavior.
- **Discuss** situations in which applying a hydrophobic or hydrophilic surface would be advantageous.

Skills

- **Recognize** and **understand** the general composition of elements and their organization into a chemical structure including bonding, ring structures, functional groups and dispersion properties and **relate** these to the chemical compounds of foods.

Instructional Strategies <ul style="list-style-type: none">Lecture/discussionMagic Sand vs. Regular Sand: Lab	Technology <ul style="list-style-type: none">PowerPointInternetThinkPadiPadInteractive White Board	Instructional Strategies <ul style="list-style-type: none">Investigating Contact Angles: Lab	Technology <ul style="list-style-type: none">ThinkPadiPadInteractive White Board	Instructional Strategies <ul style="list-style-type: none">DiscussionHydrophobic and Hydrophilic Reactions in Milk: Lab	Technology <ul style="list-style-type: none">PowerPointInternetThinkPadiPadInteractive White Board
Assessment <ul style="list-style-type: none">Magic Sand vs. Regular Sand: Lab		Assessment <ul style="list-style-type: none">Investigating Contact Angles: Lab		Assessment <ul style="list-style-type: none">Hydrophobic and Hydrophilic Reactions in Milk: Lab	
Resources <ul style="list-style-type: none">Regents of the University of Colorado					

Wetting and Contact Angle: Lesson

Objectives:

- **Define** the term “wetting” and describe how total wetting, partial wetting, and no wetting are different.
- **Observe** how different surfaces are used to maintain visibility under different conditions.
- **Discuss** situations in which applying a hydrophilic or hydrophobic surface would be advantageous.

Essential Questions:

1. What makes water stick to itself and form bubbles and droplets?
2. Why do water droplets stick to things?
3. What causes water to be absorbed by a paper towel or move up a capillary tube?



Figure 1. While driving, visibility can be reduced by the rain falling outside and the condensation forming on the windshield inside. By changing the surface properties of the windshield, visibility can be improved. Copyright.

Group Discussion:

1. What is happening to the rain on the windshield?
2. In order to see better through the windshield, how would you rather the water acted?
3. Do you want the water to stick to the surface or pull off it?
4. What could you do to make visibility better?
5. What is causing the windows to fog up? How does this affect visibility?

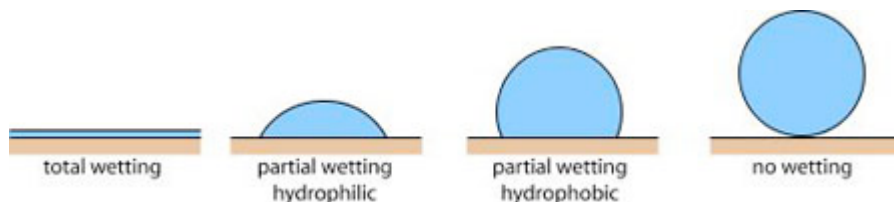


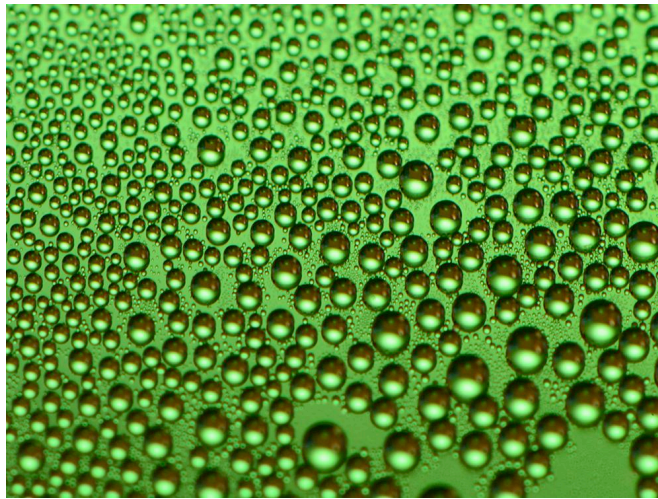
Figure 2: On a hydrophilic surface a water drop spreads out to increase the contact surface. On a hydrophobic surface a water drop contracts to minimize the contact surface. Copyright.

- ✚ When a liquid drop is placed onto a solid surface, the behavior depends on the adhesive forces between the liquid and the surface:
 - Adhesion = water is attracted to other substances
 - Cohesion = water is attracted to water
- ✚ If the adhesive forces are attractive, the liquid drop is pulled toward the surface and spreads along the surface (hydrophilic).
- ✚ If the adhesive force repel, the liquid drop minimizes its contact with the surface and the drop will “bead” (hydrophobic)



Figure 3: hydrophilic vs. hydrophobic

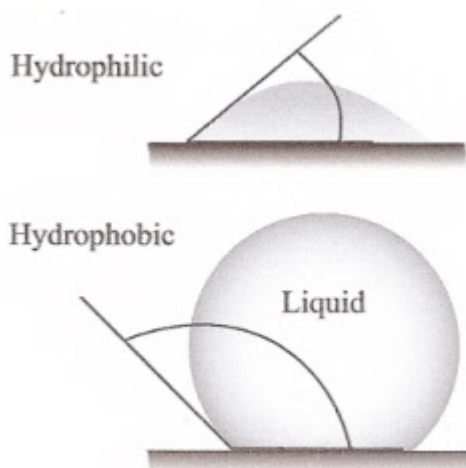
Identify the pictures below as hydrophobic or hydrophilic:





Hydrophobic materials and coatings are used to make things such as water-repellant clothing and backpacks. The inside of milk cartons is coated with wax, which is a hydrophobic material, to make them waterproof. Wax is also applied to cars and other vehicles to protect them from the weather. Chemical engineers incorporate hydrophobic elements into outdoor paints and stains to protect wood and other building materials from the elements.

Adding "wetting" agents to lower the contact angle and allow liquids to spread are also useful in many areas. Wetting agents increase the ability of paints and other coatings to spread and penetrate surfaces. They improve the surface contact, and therefore improve adhesion, of cements and glues. Anti-fogging coatings are added to camera lenses and diving masks so that condensation forms a thin, transparent sheet of water rather than many small droplets that impede vision.



Activity: Three-Minute Writing: In your Science Journals, write down everything you learned from this lesson. The notes you create do NOT need to be in any specific order. You may also use drawings with descriptions. You are to do this from memory (meaning do not look at your notes).

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Name(s): _____

Date: _____

Magic Sand vs. Regular Sand








Objectives:

- **Explore** the properties of molecular bonding
- **Demonstrate** the concepts of hydrophobic and hydrophilic behavior

Overview:

As we have learned in class, regular sand is polar (making it hydrophilic). This polarity allows the H₂O of the sand to stick together. Think about when you build a sand castle. The castle will bind together when water is added. In this experiment, you and your partners will consider the differences between magic sand and beach sand in different solvents. You will also come up with various explanations for these occurrences.

Materials:

-  4 400 mL beakers
-  500 mL of H₂O
-  500 mL of vegetable oil
-  Balance
-  Mixing rod
-  15 grams of Magic Sand
-  15 grams of Beach Sand

Pre-Lab Questions:

1. What do you know about regular sand vs. magic sand?
2. Define hydrophobic and provide an example.
3. Define hydrophilic and provide an example.
4. What causes a substance to be either hydrophobic or hydrophilic?

Develop a hypothesis about what properties different sands and solvents will have. Write your hypothesis below:

Procedure:

1. Pour 250 mL of each solvent (oil and water) into separate beakers (make sure you label your beakers).
2. Place about 5 grams of beach sand in each of the solvents.
3. Wait about 2 minutes and record your observations. Use the mixing rod to displace the sand and record your observations in data table 1.
4. Repeat the same procedure using the magic sand and record your observations in data table 1.

Data Table 1

<i>Substance</i>	<i>H₂O</i>	<i>Oil</i>
Beach Sand		
Magic Sand		

Analysis:

Fill out the following table below by checking either polar or non-polar and provide a brief explanation on your choice.

<i>Material</i>	<i>Polar</i>	<i>Non-Polar</i>	<i>Reason</i>
Oil			
H ₂ O			
Beach Sand			
Magic Sand			

Questions:

1. What occurred when you poured the regular sand into the first beaker of H₂O? Be as descriptive as possible.
2. What occurred when you poured the magic sand into the second beaker of H₂O? Be as descriptive as possible.
3. How can magic sand be used in real life?

Name(s): _____

Date: _____

Investigating Contact Angles: Lab

Objective:

- ✚ Describe and predict the behavior of water on hydrophobic and hydrophilic surfaces and explain in general terms what causes the difference in behavior.
- ✚ Discuss situations in which applying a hydrophilic or hydrophobic surface would be advantageous.

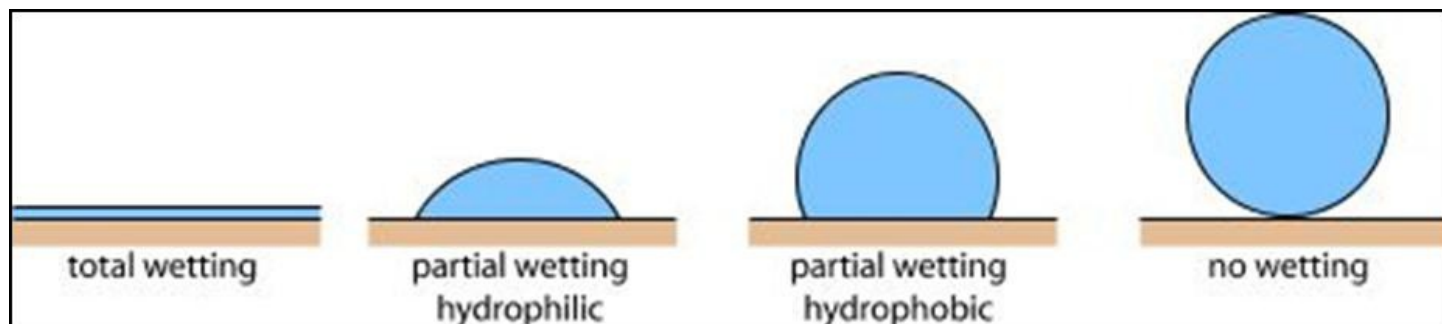
Materials:

- | | |
|---------------------------------------|----------------------------------|
| ✚ Lab goggles & aprons | ✚ Hot plate |
| ✚ 3-5 microscope slides (pre-treated) | ✚ Tongs |
| ✚ Pipette | ✚ Microscope or magnifying glass |
| ✚ Beaker | ✚ Lab gloves |
| ✚ Stop watch | ✚ School iPad |

Part A – Observing:

Introduction:

You will receive up to 5 slides that are labeled A-E. Only one slide will be regular glass while the other four slides are treated with various glass treatments. These treatments will allow you to observe the change in surface properties and you will observe how water acts on these surfaces.



Procedure:

- On each glass slide, place 1 drop of water using the pipette provided. Observe the shape of the water droplet on the glass. Record your data in the table below and describe OR sketch what they look like.
- Using your iPad, take a picture of all 5 slides to show their position
- Next, pick up each slide carefully and tilt the slide from side to side. How does the water drop behave on each slide (record your observations in the data table below).
- After your observations, determine whether each surface is hydrophobic or hydrophilic (record your observations in the data table below).
 - Which slide was the most hydrophobic? _____
 - Which slide was the most hydrophilic? _____

<i>Slide</i>	<i>Water Drop Shape</i>	<i>Behavior When Tilted</i>	<i>Hydrophobic or Hydrophilic</i>
A			
B			
C			
D			
E			

Part B: Increasing Visibility in a Rain Storm

Introduction:

If you have ever driven through a heavy downpour, you know rain can make it difficult to see the road or other cars. To improve visibility during a rainstorm, it is best if the windshield is able to shed water as fast as possible. In this part of the lab, you will test the surface coatings from Part A and decide which would be the best product to apply to the outside of a windshield to improve visibility during a rainstorm.

Prediction:

In Part A, you observed the effect on water of different surface coatings. Using these observations, would you expect a hydrophobic or hydrophilic surface to shed water fastest? Which glass surface, A-E, do you expect to work best in a rain storm? (Explain your answer below and provide evidence from part A)

Procedure:

1. Fill a small beaker of water.
2. Hold the microscope slide with coating A over a sink at an angle. When ready, pour the beaker of water down the side of the slide. Observe the water moving on the slide and record your observations in the table, below.
3. Repeat steps 1-2 for the other coated slides.

<i>Glass Coating</i>	<i>Observations</i>
A	
B	
C	
D	
E	

Analysis (please write your responses in COMPLETE SENTENCES):

1. Compare your observations for Part A and for Part B. Do you notice a relationship between a surface coating's behavior in Part A and its behavior in Part B? If yes, state the relationship below.
2. Was your prediction for the best rain coating correct? If not, provide 2-3 reasons the experiment may have come out differently than you had predicted.

Part C: Anti-Fogging Properties

Introduction:

Another important application for glass treatments is to avoid the reduced visibility caused by the condensation forming on glasses, goggles, windshields and other glass and plastic surfaces. In this section, you will predict which glass coating avoids this loss of visibility and perform experiments to test your prediction.

Prediction:

Use your observations from Part A to predict what type of surface coating has better anti-fogging properties, hydrophobic or hydrophilic. Which glass surface, A-E, do you expect to work the best? (Explain your answers below and use evidence from Part A and B to support your answers.)

Procedure:

1. Fill a beaker with water and place it on a hot plate (make sure the heat is on medium).
2. Wait five minutes (you want the water to be hot NOT boiling).
3. Hold each slide above the beaker for 30 s (you want to use the tongs to hold each slide). Before removing each slide, note the following observations:
 - a. Has water condensed onto the slide?
 - b. Has visibility been reduced through the glass? (Has it become foggy?) Record your observations in the table, below.

<i>Glass Coating</i>	<i>Did water condense?</i>	<i>Has the slide become foggy?</i>
A		
B		
C		
D		
E		

Analysis:

1. Compare your observations for Part A with your observations for Part C. Do you notice a correlation to the two behaviors?
2. Was your prediction for the best anti-fogging agent correct? If not, provide 2-3 reasons the experiment may have come out differently than you had predicted.

Name(s): _____

Date: _____

Hydrophobic and Hydrophilic Reactions in Milk

Objective:

- **Recognize** and **understand** the general composition of elements and their organization into a chemical structure including bonding, ring structures, functional groups and dispersion properties and **relate** these to the chemical compounds of foods.

Materials:

- 2% milk
- Food coloring
- Dish washing soap
- Cotton swabs
- Dinner plates
- iPad (stopwatch)

Procedure:

1. Pour milk in the dinner plate. You want to pour enough to cover the entire bottom of the plate.
2. Add 1 drop each of the four colors to the milk. Make sure to keep the drops close together and in the center of the plate.
3. Predict what will happen when you touch the tip of a cotton swab to the center of the milk. Write your thoughts below:
4. Take the cotton swab and gently touch the center of the milk. Make sure to record your observations.
5. Place a small drop of the dish washing soap on the tip of the cotton swab.
6. Place the soapy end back in the middle of the milk and hold there for 15 seconds. Describe what happens.
7. Add another drop of soap to the tip of the cotton swab and try it again. Try placing the cotton swab with dishing washing soap on another area (other than the center). What makes the food coloring in the milk move?




What causes the food coloring to move through the milk?

Analyzing Results (remember COMPLETE sentences):

1. When you first put the cotton swab (with no dishwashing soap) in the milk what did your group observe?
2. How about when you put the cotton swab with dish washing soap in the milk for the first time what did your group observe?
3. When you placed the cotton swab with dishing washing soap in the milk for the second time what happened? How about when you placed the cotton swab in different locations?
4. By observing what happened in this quick lab, explain in your own words (as a group) the difference between hydrophobic and hydrophilic reactions.

Going Further:

1. Now test other variables.
2. Does the type of milk affect the outcome?
3. Can you do this with other liquids?
4. Will something other than dish washing soap work?

-  Your group will test these variables in class so as a group you need to decide what you would like to test. You will be conducting these experiments NEXT class. I will provide the food coloring, plates, cotton swabs and milk (basically whatever new variables you will like to test you will need to bring).
 - Your group will record your observations in lab paper format to be turned in.
 - Using your iPads, I will also like you to record a video of your group's experiments (we will watch these in class).