Penn State RET in Interdisciplinary Materials

Teacher's Preparatory Guide

Investigating Surface Tension and Hydrophobic Properties

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Purpose This lab is designed to help students understand the hydrophobicity of plants and how it is replicated.

Objectives Students will measure contact angles and make replica molds of hydrophobic plant samples to collect and compare data between the naturally-occurring and reproduced samples to determine the hydrophobicity of the surfaces.

Time required 5- 40 minute class periods

Level Middle School- Grade 5-8

PA COMMON CORE STNDS:
S8.A.1.1.2-Explain how certain questions can be answered through scientific inquiry
S8.A.1.1.3-Use evidence such as observations or experimental results, to support inferences about a relationship
S8.A.1.1.4-Develop descriptions, explanations, predictions, and models using evidence
S8.A.3.3.2-Describe repeating structure patterns in nature or periodic patterns
S8.B.1.1.2-Comapare similarities or differences in both internal structures and external structures of organisms

Teacher Background Prior to the introduction of these lessons it will be necessary to have students build background knowledge on surface tension. Students should have a basic understanding of surface tension, the 'lotus effect', and hydrophobic and superhydrophic properties. In addition, students will need to be proficient on using a protractor to find angles.

The Lotus Effect- explanation for kids
https://www.pitara.com/science-for-kids/science-news-for-kids/how-does-the-lotus-flower-clean-itself/
Superhydrophobicity
https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less4
Surface Tension
https://www.scientificamerican.com/article/measure-surface-tension-with-a-penny/
Protractor
https://www.khanacademy.org/math/basic-geo/basic-geo-angle/measure-angles/v/using-a-protractor

Materials

- Five disposable pipettes (per group)
- Various leaf samples
- PDMS
- Mini Dixie cups
- Pvc pipe 1 1/2-inch segments (10)
- Petri dishes (10)
- Weights (to put on top of pvc pipe)
- Green organic oil-based dye
- Two Jumbo Binder Clips (per group)
- Protractor (class set)
- One iPad (per group)
- Eyewear protection
- Disposable gloves
- Paper towels
- Pen and Lab Packet (one set per group)

Advance Preparation

Collect hydrophobic plant samples.
Make PDMS the day before so that it can sit and the air bubbles can be removed.

Safety Information Protective eye wear and gloves will be worn by students during lab.

Teaching Strategies This lab should be completed in groups of approximately 4 students.
Review the procedures for the lab and the general lab safety rules with the class ahead of time.

Resources: You may wish to use these resources either as background or as a resource for students to use in their inquiry-based design.

How to use a protractor:
https://www.khanacademy.org/math/basic-geo/basic-geo-angle/measure-angles/v/using-a-protractor

Milk Experiment (hydrophobic and hydrophilic)
https://www.teacherspayteachers.com/FreeDownload/Color-Changing-MIlk-an-easy-experiment-using-common-household-items-780102

The Lotus Effect- explanation for kids
https://www.pitara.com/science-for-kids/science-news-for-kids/how-does-the-lotus-flower-clean-itself/

Superhydrophobicity
https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less4

Surface Tension
https://www.scientificamerican.com/article/measure-surface-tension-with-a-penny/

Directions for the activities

Day 1- Measure and Record Contact Angles for Plant Samples

Students will need an iPad, protractor, pipette, water, and protective eyewear.

Using a plant sample, students will measure contact angle to determine the hydrophobicity of the plant.

- Place flattened plant on a level surface.
- Set iPad up so that plant is in view and the iPad and plant are level.
- Using pipette, place a drop of water on flat surface of plant. Make sure you can see it in the view on the iPad.
- Take a photo of the drop with the least amount of movement to get a clear picture.
- Repeat the trial 5 times.
- Repeat the process for each plant sample.
- Use protractor to measure contact angle in each picture obtained.

Clean up any supplies and store samples and materials in designated locations.

Day 2- Make Negative PDMS Molds of Plant Samples

Students will need pvc circles, petri dishes, mini dixie cups, weights, gloves and goggles.

Using the PDMS that was made up previously (this can be done by teacher and student helpers the day before), students will make negative PDMS molds of plant samples that were used in trials.

- Put a very small amount of PDMS on bottom of petri dish. This will act as a 'glue' to simply hold the sample in place.
- Place plant sample in the petri dish stuck onto the PDMS. Make sure the top side of the plant is facing up.
- Place pvc pipe circle on top of plant sample. Hold the pvc pipe flat on plant as you pour PDMS into the circle to make your mold.
    - **Only fill approximately 1/3 or a half inch of PDMS into the pipe.
- Place weight on top of pvc pipe.
    - **This will prevent leaking of PDMS material from the where the pc pipe meets your plant sample.
- Place petri dish in designated undisturbed location.
- Repeat process for each plant sample.

Clean up any supplies and store samples and materials in designated locations. Samples will need to sit until PDMS materials has formed into a solid. This may take a few days.

Day 3- Make Positive PDMS Molds

Students will need pvc circles, petri dishes, weights, gloves and goggles.

Using the PDMS with green organic oil-based dye that was made up previously (this can be done by teacher and student helpers the day before), students will make positive PDMS molds of plant samples that were used in trials. This will be done from making a mold from the previously made negative mold.

- Carefully remove the pvc pipe off from the plant sample.
- Make sure there are no plant sample particles on the sample inside the pvc pipe.
    - **mold must now sit in UV/Sun light for 2 days (or UV box- if available)
    - **then spray mold with McGuires wax spray

- Remove the circle mold and flip it over to reinsert with the negative mold side up. Reinsert the circle mold back into the pipe.
- Place the pvc pipe back onto a petri dish.
- With the mold reinserted, pour the green-dyed PDMS into the pipe again so that is it being poured onto the textured side of the mold.
- Place petri dish in designated undisturbed location.
- Repeat process for each plant sample.

Clean up any supplies and store samples and materials in designated locations.

Day 4- Measure and Record Contact Angles for Positive Molds

Students will need an iPad, protractor, pipette, water, and protective eyewear.

Using positive molds, students will measure contact angle to determine the hydrophobicity of the mold.

- Place PDMS mold on a level surface.
- Set iPad up so that mold is in view and the iPad and mold are level.
- Using pipette, place a drop of water on flat surface of mold. Make sure you can see it in the view on the iPad.
- Take a photo of the drop with the least amount of movement to get a clear picture.
- Repeat the trial 5 times.
- Repeat the process for each mold.
- Use protractor to measure contact angle in each picture obtained.

Clean up any supplies and store samples and materials in designated locations.

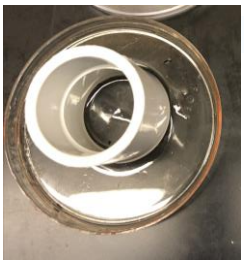
Day 5- Summary of Results- Culminating Discussion

Complete Lab Packets.

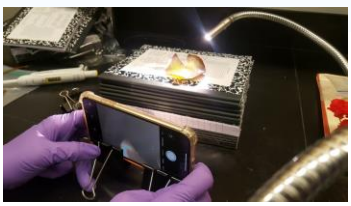
In Lab Notebooks- Students will record and compare their results. Write a summary explaining their results and what steps they would take next. Share out in a whole group discussion to compare group results within the classroom.

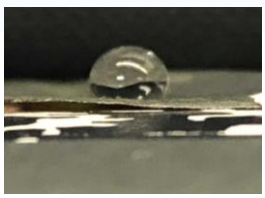
Procedure

Making PDMS Molds



Measuring Contact Angles





Lab Packet

Name: _____ Date:_____

Title: _____

Background Information:

Question:

_____

_____

Prediction:

_____

_____

Materials:

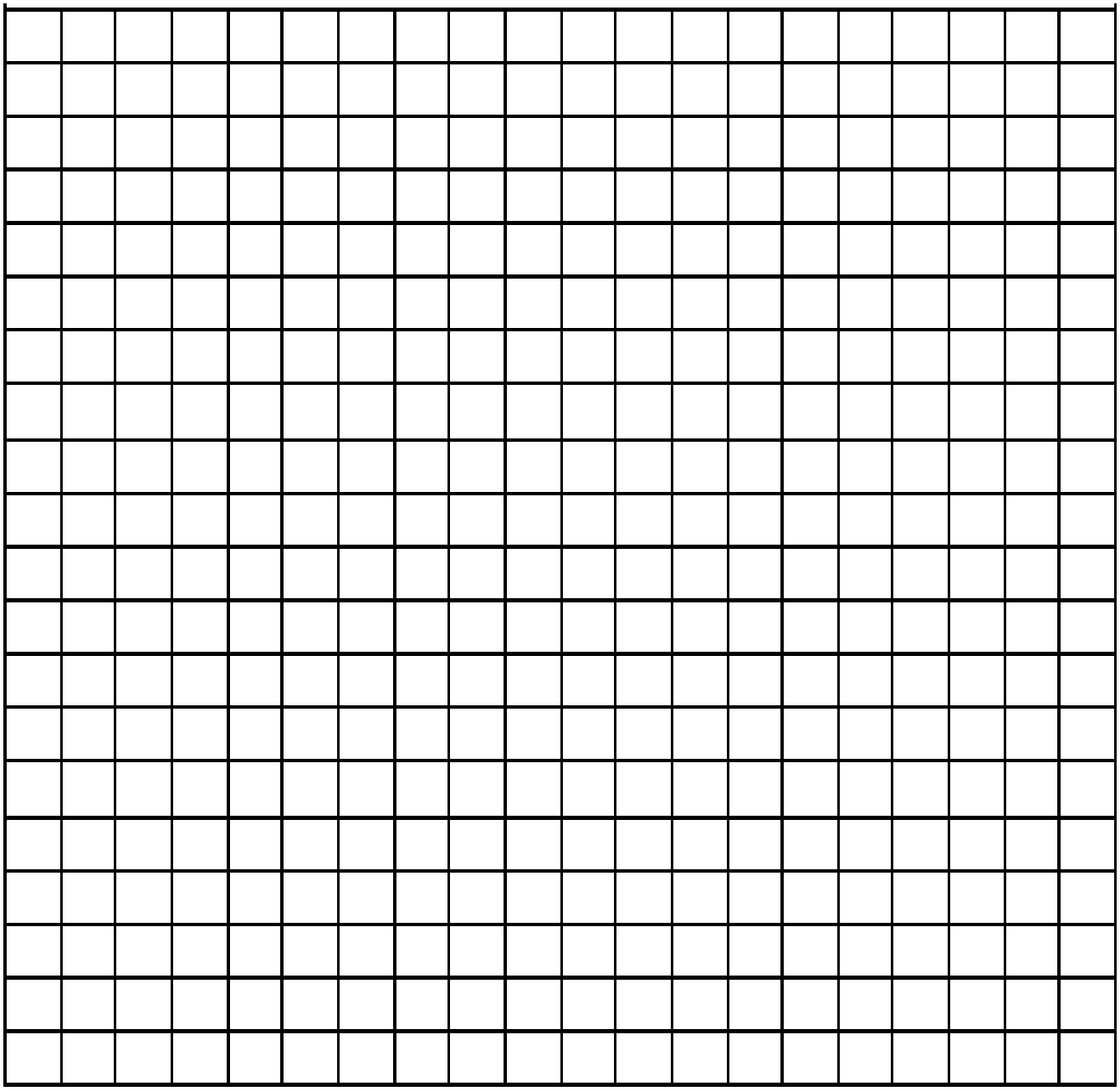
Identify Variables:

Procedure/Plan:

Collect and Interpret Data

Make data charts in the space provided. Be sure to include labels and write neatly.

Graph Data



Conclusion

What data supports your conclusion?

Further Investigation: