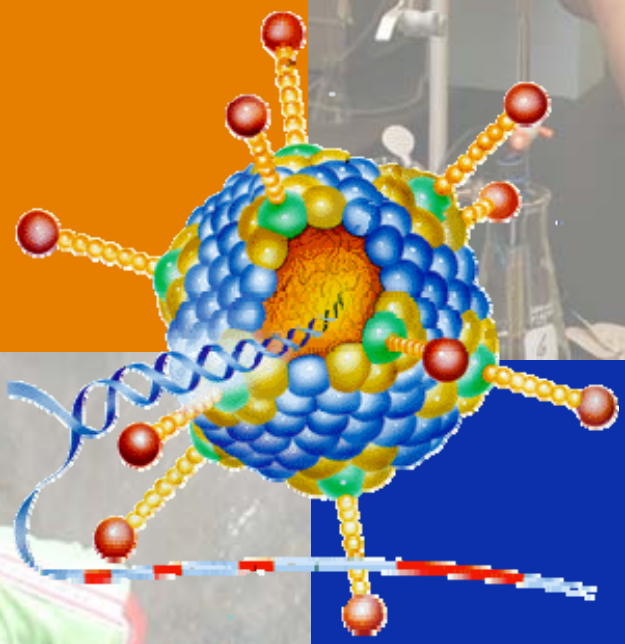
Magic Sand and the Hydrophobic Effect

Lab Book



The waterCAMPWS
Center for Advanced Materials
for Purification of Water with Systems

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University of Illinois at Urbana-Champaign

Overview

Normal beach sand is polar, which makes it hydrophilic. When sand comes in contact with water, the polarity of the water causes it to become a type of glue that helps stick the sand together. (http://www.aip.org/isns/reports/2003/069.html) Anyone who has tried to build a sand castle knows that wet sand holds it shape much better than dry sand. In this experiment, you will consider the differences between the behavior of magic sand and beach sand in different solvents and come up with explanations for these occurrences. After completing this laboratory activity you will:

- Have a basic understanding of entropy and its significance as a thermodynamic force
- Be able to explain why the polarity of a solvent can affect the behavior of the solute
- Be aware of the importance of the hydrophobic affect in biological systems.

Materials and Equipment

Materials required for this lesson are (for each group of students):
6 400mL beakers, each containing

- 500 mL of H2O
- 500 mL of mineral or vegetable oil
- Balance
- 15 grams of beach sand
- 15 grams of magic sand
- Mixing rod

Procedure

1. Before beginning the experiment, develop a hypothesis about what properties different sands and solvents will have. Write your hypothesis below:

2. Pour 250 mL of each solvent (water, oil) into separate beakers. Label each beaker.

3. Place about 5 grams of beach sand in each of the solvents.

4. Wait 1-2 minutes and record your observations. Use the mixing rod to displace the sand and record any new observations in the space provided in the results section.

5. Repeat this procedure using magic sand.

The Good, the Bad, the Silly…

Writing a good hypothesis is harder than you think. For example:

When it gets cold, water turns to ice.

is an acceptable hypothesis, but not very helpful, since there are temperature ranges of "cold" when ice wouldn't form.

A better hypothesis would be:

When the temperature reaches 32 degrees Fahrenheit and remains at that temperature, water turns to ice.

The hypothesis:

When the temperature reaches 32 degrees Fahrenheit and remains at that temperature in a room with three windows that face North on a Sunday, water turns to ice.

While this last statement may be true, it contains a lot of unnecessary detail that makes it of little practical value, since there are lots of conditions that will cause ice to form that are excluded in this hypothesis.

Results

Observation Chart:

In the chart below record your observations of the beach and magic sand in the water and then the oil.

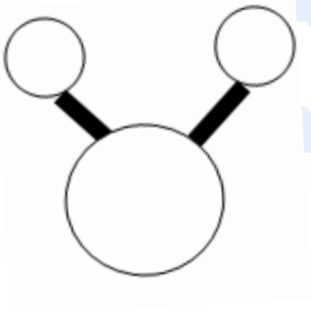
Substance	Water	Oil
Beach Sand		
Magic Sand		

Analysis

1. Fill out the table by checking either polar or nonpolar and then giving a brief explanation as to why you choose that choice.

Material	Polar	Non-Polar	Reason for choice
Oil			
Water			
Beach Sand			
Magic Sand			

2. A water molecule is shown below. Show where charges exist by drawing - and + on the atoms in the molecule. (δ)



3. Magic sand is essentially beach sand that is coated with particles of chemically treated silica. Each grain now has methyl groups (CH_3) attached to its exterior. What physical property must the methyl groups have to make the sand hydrophobic?

4. Would most materials that pass through our blood stream be hydrophobic or hydrophilic? Explain your reasoning.

5. What physical properties allow water to form the "ice cage" around the methane gas? Why does this phenomenon occur?

6. Can you think of any ways in which magic sand can be used in real life?

7. In your own words, write an explanation of the second law of thermodynamics. In a second paragraph, explain one point learned in this exercise that you would share with your parents or friends.