Cloverbud Investigators: Career Detectives

The Magic of Sandcastles

August

Objectives: Investigators will learn about the structural and chemical makeup of sand and how it creates the magic that holds sandcastles together!

Background:
What is sand? Sand is a granular material made up of rock and mineral. Most sand is made up of the mineral silica, normally in the form of quartz. Quartz is a chemical compound consisting of one-part silicon and two parts oxygen. It is one of the most abundant minerals found on the surface of Earth. The second most common type of sand is a calcium carbonate, which is formed over millions of years by various forms of life, like coral and shells.

The composition of sand can vary depending on where it originated. Sand is a hard, non-renewable, (in the since that it takes thousands of years to form naturally), useful product. Because of sand's hardness and texture, it is mixed with products like asphalt and concrete. It gives form and strength to bricks, blocks, and foundations. Sand has been used for everything from water filtration, to artistic mediums, but did you know that sand can be absorbent? Even though grains of sand are very hard they are made up of pores, tiny holes normally filled with air when dry. When grains of sand are placed in a liquid, the pores soak up it up, locking it in place. These same absorbent properties are what allows us to build sandcastles. Have you ever tried to build a sandcastle with dry sand? What happens? The sand grains will not stick together, and your castle ends up just a pile of sand. So how do you make a sandcastle? Everyone knows you must use wet sand. By allowing the sand to get wet, you are filling the pores with water. It is the water contained in these pores that form a bond and hold the grains of sand together. Water molecules bonding with other molecules stick together, just like water tension on the surface of a pond. Water molecules on the grains of sand, bond or build little bridges between each other and this holds the grains of sand in place. In nature, sand is naturally hydrophilic or "water loving". Water molecules will adhere or stick directly to the sand grains. The water does not react with the grains, it is not making them sticky, it is simply holding them together. When the sand is dry, there are no water molecules to build those bonds and the sand grains will not stick together.

In this investigation, we will look at the physical structure of sand and why sand sticks together when it is wet but not when it is dry. Then we will see if we can alter the sand to change its water Hydrophilic (water loving) qualities to Hydrophobic (water fearing) qualities.

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Step 1. Using play sand allow students time to explore the properties of sand. First, have them pack dry sand into a plastic cup and try to make a sandcastle. Talk about what happened. Did the sand hold together?

Step 2. Ask them what they need to do to the sand to build a sandcastle? Once they guess that they will need wet sand, allow them to spread their sand out and add moisture by spraying the sand with water. Again, pack the now damp sand into a plastic cup and try to make a sandcastle. What happened this time? Why did the wet sand stick together when the dry sand fell apart?

Step 3. Let's take a look at some sand under the microscope. Ask the following:

- Do the sand grains have different colors, shapes, or sizes? Do you think the size, color or shape has anything to do with why the sand stuck together when it was wet? but not when it was dry?
- If you look closely can you see any pores or small holes on the grains of sand? Do you think these small holes might play apart in why the sand stuck together when it was wet? But not when it was dry? *Talk about it:* the holes would be filled with what when the sand is dry? *(air) (nothing)* but when we wet the sand the holes filled up with what? *(water)*

Science behind it: Water molecules love to stick together; scientists call this Hydrophilic or water loving. Some substances like water and bond with it quite easy. In nature, we see this property when we look at water surface tension. Have you ever looked at the surface of a pond and seen insects floating or walking across the water? What you are seeing is surface tension. The molecules of water have made a bond and the insect is being held up by those bonds.

Using this knowledge of water molecules, ask the students to come up with a theory as to why the wet sand sticks together. Once they have guessed that the water on the sand grains are bonding together and this is holding the grains of sand in place, ask them can sand be wet but not stick together? Our next experiment will answer that question, but first we must make our Hydrophilic (water loving) grain of sand become Hydrophobic (water fearing). How do we do that? Ask the students "Do you know of anything that just won't mix with water?" If they struggle to come up with something, show them a small jar of water, add some vegetable oil to the jar. Ask: "Does the oil mix with the water?" Try shaking the jar, did it mix? It does not mix because oil is Hydrophobic, it does not like water and will not bond with it. Then say, "So let's use this information to make our sand grains Hydrophobic".

Local Career Connections: Careers to discuss

- Chemist
- Geologists
- Marine/Wildlife Biologist
- Ecologist
- Inventors

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August's Mystery: How can my sand stay dry but be underwater?

***Supplies*:**

- Craft Sand
- Food Coloring
- Scotch Guard
- Plastic Baggie
- Cookie Sheet
- Water
- Tank or Jar to play with sand
- Container to store sand
- (Optional-Microscope)

The idea of magic sand was first invented to trap ocean oil spills near the shore. The idea was that by adding the sand to the floating petroleum it would bond to the petroleum and sink it into collection container. However, this method proved to be very expensive.

The Science behind "Magic Sand": Spraying the individual grains of sand with Scotch Guard a Hydrophobic product, which repeals liquid, will preventing the water molecules from creating bonds. Essentially, you are keeping the small pores on the grains of sand filled with air and coating the surface of the sand grain so the water molecules cannot attach. You will see that when the magic sand is submerged in the water a shiny silvery coating seems to cover the sand. This is the air molecules keeping the sand from bonding with the water, basically the sand is not getting wet.

Warning: While the chemical make-up of Scotch Guard has been changed over the years to make it safer for humans and pets, Scotch guard is still a chemical compound and should not come in contact with eyes or eaten. Wash hands after playing with the sand. Always spray Scotch Guard in a well-ventilated area, using adult supervision.

What to Do:

Step 1: Place 1 cup of sand in a plastic bag and add food coloring.

Step 2: Close the bag and shake to fully cover the sand with color.

Step 3: Spread the sand on a cookie sheet and bake at 200 degrees for 25-30 minutes to remove the moisture. Let the sand cool after drying.

Step 4: With adult help, in a well-ventilated area, spray the sand with scotch guard and shake to cover. Repeat 3-4 times letting the sand dry between each spray.

Step 5: Now you are ready to test it out!

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Step 6: Put the sand in the water. What happened?

Note: Store the dry sand in an airtight container. Eventually the scotch guard will wear away and the sand will act like regular sand again. To refresh just repeat step 4.

Go Over Findings:

Did the natural sand get wet? Why or why not?

Did the Magic Sand get wet? Why or why not?

What prevented the magic sand grains from bonding with the water molecules (getting wet)?

Why are the small pores or holes in the grains of sand important?

Which is better for building sandcastles, wet or dry sand? So, can I build a sandcastle with Magic sand?

Investigate, Create, & Take: Investigators can take with them:

- ✓ Sand Art option: Make sand grains stick together permanently by making sand clay. Combine sand, corn starch and glue see recipe:

Ingredients –

1. 1/2 Cups Sand
2. 1 1/2 Cups Corn flour
3. 2 Cups Bi Carb Soda
4. 1 1/2 Cups Water

Method –Mix all the ingredients in a saucepan. Heat over a med-high heat while continually stirring until the mixture thickens and resembles a thick dough. Empty the dough onto a sheet of baking paper and allow to cool under a damp towel. Once the dough is cool enough to touch you can kneed it until smooth. Shape the dough and allow it to dry to prematurely form your sandcastle.

- ✓ Look at the sand grains under a microscope, check out the colors, sizes, and structure.
- ✓ Take home a bag of Magic Sand

Sources:

Steve Spangler Science: Magic Sand-
https://www.stevespanglerscience.com/lab/experiments/magic-hydrophobic-sand/

YouTube video: Sandy Clay Dough Recipe - Build a Sandcastle Indoors -
https://www.youtube.com/watch?v=7hCT4cWnr_s

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