



Mission: How is the strength of a sand tower affected by its ingredients?

Age: 8+

Materials: \$18

Time: 1 hour 15 min

(Set-up: 10 min Activity: 60 min with wait time Clean-up: 5 min)

What you need:

Materials:

- Permanent marker
- 3 index cards, cut in half
- 1/3 cup water
- 1/3 cup hand sanitizer
- 1/3 cup vegetable oil
- 4 cups of sand
- 100 pennies (one \$1 roll)
- Data sheet (found on page 4)

Equipment:

- 1/3-cup liquid measuring cup
- 1-cup dry measuring cup
- 8 disposable 3-ounce paper cups
- 4 paper plates
- 3 paper bowls
- 3 plastic spoons

What to do:

1. With the marker, label four paper cups like this: "Sand," "Sand + Water," "Sand + Hand Sanitizer," "Sand + Vegetable Oil."
2. Label four paper plates with the same names as the cups, leaving the middle of the plate open.
3. Label three paper bowls as well with: "Water," "Hand Sanitizer," and "Vegetable Oil."
4. Pour 1/3 cup of each liquid into its labeled bowl. Add 1 cup of sand to each bowl. Stir each mixture with a spoon. How do the liquids mix differently?
5. Fill and press each mixture into its labeled paper cup. The cup labeled 'sand' should be filled with dry sand. This will be used as a comparison to the other mixtures, or as scientists say, "the control." Allow the filled cups to set for 45 minutes.
6. Once the cups have set, place the paper plate labeled with the correct mixture face down over each cup. Holding from the top and bottom, flip each one over so the plate is now underneath the cup and place it back on the table. Lift the cup away to reveal the sand structure. What differences do you observe as you remove the cups?

What to do:

7. Based on your observations so far, can you predict which sand mixture will hold the most weight? Place half of an index card across the top of each remaining sand structure and put an empty paper cup on top. Start adding pennies to the cup and record the number of pennies it takes for each structure to collapse. Were your predictions accurate?

Clean-up:

Wash measuring cups. Throw used paper products and sand mixtures in the trash. Save any extra unused sand, hand sanitizer and vegetable oil for other purposes. And save your pennies!

What's Happening?

Notice that the sand or any of the liquids by themselves can't hold very many pennies. Once the sand is combined with a liquid, the sand structures are able to hold much more. The mixing of the sand with a liquid created a substance which is stronger than either of the individual starting materials. For our sand structures, this is due to the forces with which the molecules of each material stick to each other. Each liquid has forces of different strength at play, resulting in each mixture being able to support a different amount of weight.

So What?



Composite materials are those which combine two or more materials and when combined have properties that are unique to their individual parts. In your experiment, the combinations resulted in greater structural stability. Other composite materials result in new properties of weight, strength, and more. This ability to create a mixture which is greater than the sum of its parts presents great possibility to create materials with useful properties for a wide range of applications. For example, the concrete inside of a bridge is a composite made of sand, water and cement. For another example, carbon fiber composites combine ultra-thin strands of carbon with different polymers to create high strength and low weight materials that can conduct electricity. Using different combinations, carbon fiber composites can be found in wind turbine blades, aircraft, sports equipment and high-performance cars, and even potentially artificial skin.

SAND STRUCTURES

MATERIALS

INITIAL OBSERVATIONS

PENNY TEST

Sand		
Sand + Hand Sanitizer		
Sand + Vegetable Oil		
Sand + Water		

NGSS Alignment of Sand Structures Activity

The information below may not include every area that this activity can be linked to NGSS concepts

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- **Grade 2**

- ◇ Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.
- ◇ Different properties are suited to different purposes.

- **Grade 5**

- ◇ Measurements of a variety of properties can be used to identify materials.

PS1.B: Chemical Reactions

- **Grade 5**

- ◇ When two or more different substances are mixed, a new substance with different properties may be formed.

Performance Expectations

2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

5-PS1-3: Make observations and measurements to identify materials based on their properties.

5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Crosscutting Concepts:

Planning and Carrying Out Investigations

- **Grade 3-5**

- ◇ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- ◇ Make predictions about what would happen if a variable changes.
- ◇ Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

Crosscutting Concepts:

Planning and Carrying Out Investigations

- Middle School
 - ◇ Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.
 - ◇ Collect data about the performance of a proposed object, tool, process, or system under a range of conditions.

Constructing Explanations and Designing Solutions

- Grade 3-5
 - ◇ Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
 - ◇ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.
- Middle School
 - ◇ Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
 - ◇ Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Engineering and Science Practices

Planning and Carrying Out Investigations

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