

# Mystery of the Red Cups

**Title: Mystery of the Red Cups****Estimated Time: 30 Minutes****Core Ideas (GSE Standards):**

There are numerous grade-level core ideas that can be incorporated into this lesson such as the one listed for 5<sup>th</sup> grade below. However, it is a great science activity to do during the first week of school for any grade level when you are talking about the importance of scientific practices such as making observations, brainstorming ideas, and forming explanations. It also works well to discuss cross-cutting connections between the form and function of this amazing molecule. If we want our students to consider how the concepts under study are linked to other important practices and ideas, we have to them with provide opportunities to investigate and discuss them.

**5SP1. Obtain, evaluate, and, communicate information to explain the differences between a physical change & a chemical change.**

c. Plan & carry out an investigation to determine if a chemical change occurred based on observable evidence. (color, gas, temperature change, odor, new substance produced).

**Science and Engineering Practices:****Asking Questions and Defining Problems:**

Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.

**Constructing Explanations and Designing Solutions**

Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.

**Crosscutting Concepts****Patterns:**

Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

**Structure and Function**

Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

**Authentic Scenario**

In this phenomena, students investigate the properties of an amazing super absorbing polymer called sodium polyacrylate (Waterlock). It is a great science activity to do during the first week of school when you are talking about the importance of making careful observations of the world around us. In this simple activity, students make observations, form explanations, and consider cross-cutting connections between the form and function of this amazing molecule. For younger students, you can tell it as an interactive story if you prefer.

It is also a super activity to do when you are studying matter - the stuff of the universe - because you the sodium polyacrylate (Waterlock) is a chemical compound that just may be the coolest substance on the planet. It's amazing and unusual properties will fascinate your kids and they'll be eager to discuss some very important science concepts.

**Guiding Question:**

How can careful observations be used to develop reasonable explanations for an observed phenomena?

5E Stage	Student Activities How will students engage actively in the three dimensions throughout the lesson?	Teacher Activities How will the teacher facilitate and monitor student learning?
<b>Engage</b>	<ul style="list-style-type: none"> <li>• Students are shown the empty red cups and are challenged to observe closely as the teacher pours water into one of the cups.</li> <li>• Students are challenged to keep track of the cup with water as the teacher quickly shuffles the cups around.</li> <li>• After shuffling is completed, students vote on the cup that they believe has water in it.</li> </ul>	<ul style="list-style-type: none"> <li>• Show students the 3 “empty” red cups and explain their task.</li> <li>• Pour water into the target cup and shuffle the cups around quickly.</li> <li>• Allow students to vote on the cup of their choice.</li> </ul>
<b>Explore</b>	<p><b>Part 1:</b></p> <ul style="list-style-type: none"> <li>• Students observe as the teacher tips over each of the cups (they are amazed when no water pours out of the third cup).</li> <li>• Students individually brainstorm ideas (at least 3-4) explaining what happened to the water.</li> <li>• With a partner, students share and discuss their ideas.</li> <li>• As a class, students share and discuss the ideas that have been generated.</li> </ul> <p><b>Part 2:</b></p> <ul style="list-style-type: none"> <li>• Students observe carefully as the Waterlock is added to the cup of water.</li> <li>• Students observe carefully as the cup of water is inverted.</li> </ul>	<ul style="list-style-type: none"> <li>• Start with the empty cups and end by flipping over the “full” one. Gently, tap on the inverted full cup until the gel puck falls out of it.</li> <li>• Encourage the importance of students working independently to come up with own ideas.</li> <li>• Encourage the importance of working together improve and tweak ideas.</li> <li>• Show students how Waterlock works by adding small spoonful (1/2 teaspoon) to a clear cup of water and stirring quickly.</li> <li>• Invert the cup to emphasize the water absorbing effect.</li> </ul>
<b>Explain</b>	<ul style="list-style-type: none"> <li>• Students use their observations and data to explain/diagram what they think is happening between the water and the Waterlock molecules.</li> <li>• Students share ideas for how Waterlock could be used in various ways.</li> <li>• As appropriate, have students read the article <i>The Amazing Mystery Powder</i> and or read/research information about how sodium polyacrylate works and how it is used.</li> <li>• Students revise/improve their explanation of how Waterlock works based on the information obtained during reading/research.</li> <li>• Students discuss the relationship between the structure of Waterlock molecules and their function as superabsorbent polymers.</li> <li>• Students discuss whether the observed changes that occurred were physical or chemical in nature.</li> </ul>	<ul style="list-style-type: none"> <li>• If appropriate, emphasize that sodium polyacrylate is an example a polymer –a long molecule made up of repeating chains of atoms that is engineered for a particular purpose. These molecules are engineered (created) for the purpose of absorbing water (note the crosscutting relationship between structure and function).</li> <li>• Since Waterlock molecules can release water and return to its original state when conditions change, the interaction between the two represent physical and not chemical changes.</li> </ul>

<b>Elaborate</b>	Students should predict and then calculate how much water a diaper can absorb before it becomes saturated.	<ul style="list-style-type: none"> <li>This is an excellent extension activity and is well worth the time.</li> </ul>
<b>Evaluate</b>	<p><b>Formative:</b> Each student presents their revised/improved model of how Waterlock works to their group based on the information obtained during reading/research.</p> <p><b>Summative:</b> Each group summarizes their revised/improved model of how hydrogels work based on the information obtained during reading/research. Students discuss whether the observed changes were physical or chemical in nature.</p> <p>Students complete journal entries documenting observations, data, discussions, and conclusions.</p>	<p><b>Formative:</b> Facilitate ongoing questioning &amp; discussion</p> <p>Promote discussion of diagrams/models and explanations.</p> <p><b>Summative:</b> Evaluate group presentations</p> <p>Evaluate journal entries.</p>

**Teacher Notes:** Sodium polyacrylate can be purchased cheaply from Educational innovations ([www.teachersource.com](http://www.teachersource.com)) or as Water Gel from Steve Spangler ([www.SteveSpanglerScience.com](http://www.SteveSpanglerScience.com)). This is a Top 10 STEM activity because is very counterintuitive and thus it is curiosity stimulating and thought provoking. It helps students to recognize the importance of making good observations and it allows them to see how substances can undergo amazing changes when combined together. For younger elementary student, try reading the *The Mystery of the Red Cups* story while you do the key experiments.

Waterlock is a molecule that has an amazing ability to absorb up to 800 times its own weight in water. That means that if you were a 100 pound chunk of this stuff and you jumped into a swimming pool, you would absorb over 80,000 pounds of water from the pool. As a result, Waterlock is used often in places where water and water-based spills are a problem and kids are great at brainstorming new ideas for how it can be used. For example, Waterlock is used by plumbers to gel up the water from leaky pipes before it can soak in and cause major damage. But the most famous and profitable use of Waterlock is in diapers where it is sewn into the fabric so that the baby's urine (mostly water) gels rather than leaks through the diaper and pants. The extension activity is super fun for kids because they get to discover for themselves just how much water a diaper can absorb.

**Materials needed:**

- Sodium polyacrylate.
- 3 red cups (or other matching color).
- Clear plastic cup
- Plastic spoon
- Paper towels
- 1 Diaper per group (extension activity)
- 1 graduated cylinder or measuring cup per group (extension activity)
- Tap or distilled water
- Lab notebook
- Safety goggles for demonstrator
- Phone/iPad for taking pictures (optional)

**Safety Concerns:**

Always wear appropriate protective gear while conducting science demonstrations. Safety goggles should be worn by the demonstrator for this experiment

Although students will be tempted to touch the gelled powder do not allow them to do so as the powder can be transferred from their fingers to their eyes where it can irritate significantly. If this occurs, flush the eye gently with water for 10-15 minutes.

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