Hydrogels Exploration

Title: Hydrogels are Swell

Estimated Time: 2-3 Periods

Core Ideas (GSE Standards):

S5P1. Obtain, evaluate, and communicate information to explain the differences between a physical change and a chemical change.

a. Plan and carry out investigations of physical changes by manipulating, separating and mixing dry and liquid materials.

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

S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.

c. Plan and carry out investigations to compare and contrast chemical (i.e., reactivity, combustibility) and physical (i.e., density, melting point, boiling point) properties of matter.

d. Construct an argument based on observational evidence to support the claim that when a change in a substance occurs, it can be classified as either chemical or physical.
(*Clarification statement:* Evidence could include ability to separate mixtures, development of a gas, formation of a precipitate, change in energy, color, and/or form.)

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 hydrogels. **Hydrogels** are substances that can absorb and retain extremely large amounts of water relative to their own mass (but don't tell this to your students yet). They are part of a family of compounds called **Superabsorbent Polymers (SAPs)** that are unique in their ability to absorb tremendous amounts of certain liquids. In Part 1 of this lesson, students are given a sample of a hydrogel (sodium polyacrylamide) and are asked to make careful observations to record the changes in the hydrogel after placing it in water. They are then asked to develop an explanation that can be used to explain the changes that have been observed. After sharing and discussing their ideas, students read/research to learn more about the unique and useful properties of hydrogels. In Part 2 of this lesson, students design their own simple experiment that can help them to learn more about the properties and/or usefulness of hydrogels.

Guiding Question:

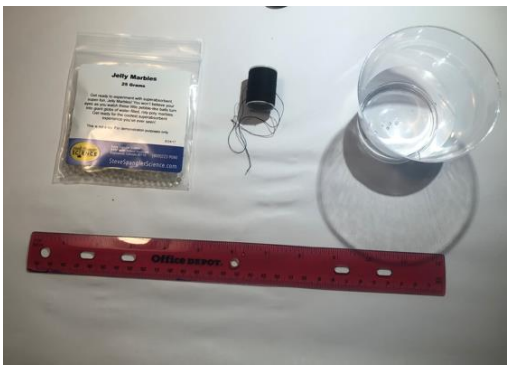
How can the unique properties of hydrogels be used to engineer solutions to water related problems?

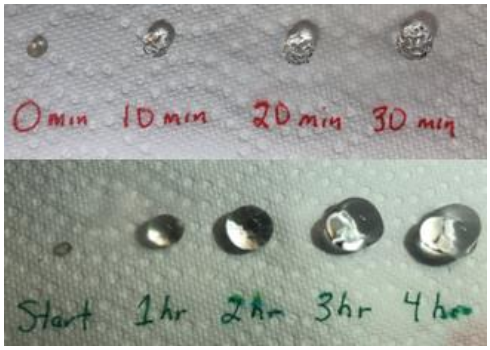
Part 1:

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?
Engage	• Student groups are given 5 hydrogel marbles and are asked to observe closely and record their observations. • Students should measure each of their marbles in 1 or 2 quantifiable ways. • Students generate questions based on their observations of the hydrogel marble. • Students predict what will happen when the hydrogel marble is placed in a cup of water.	• Distribute hydrogel marbles and magnifying glasses • Encourage students to make careful observations and measurements • Share and discuss questions and predictions that are generated
Explore	• In the exploration, students place 4 of the marbles into a small cup of water (leave one out for a control) and make and record their initial observations. • At 10 minute intervals (or 1 hour if you want to make it a day long experiement), students remove one of the marbles and carefully record and measure the changes that have occurred. • Students continue this process until each of the marbles has been removed from the water and changes have been documented. • Students use their observations and measurements to develop an explanation of what is happening between the water and the hydrogel marbles. • Students brainstorm ideas for how hydrogels might be used in effective & profitable ways. • Students place their marbles back in the water to so they can observe what happens to them overnight.	• Encourage students to make careful and detailed observations at each time interval • Ask/answer appropriate questions to guide student work as they develop their explanatory models. • Encourage students to be creative as they brainstorm uses for the hydrogel. • As appropriate, have students calculate changes in area of marble ($A = \pi r^2$) or volume of marble (V = $4/3\pi r^3$)
Explain	• Students use their observations and data to explain/diagram what they think is happening between the water and the hydrogel marble. • Students share ideas for how hydrogels could be used in various ways. • Students read/research information about hydrogels, how they work, and how they are used. • Students revise/improve their explanation of how hydrogels work based on the	• As needed, reiterate to students that one important skill of scientists and engineers is to construct explanations based on observations. • If appropriate, emphasize that each hydrogel is an example a polymer –a long molecule made up of repeating chains of atoms that is engineered for a

	information obtained during reading/research. • Students discuss the relationship between the structure of hydrogels and their function as superabsorbent polymers. • Students discuss whether the observed changes that occurred were physical or chemical in nature.	particular purpose. Hydrogels are engineered (created) for the purpose of absorbing water (note the relationship between structure and function). • Since the hydrogel can release water and return to its original state when conditions change, the interaction between the two represent physical and not chemical changes.
Elaborate	Students should predict and then calculate how much water a diaper can absorb before it becomes saturated.	
Evaluate	**Formative:** Each student presents their revised/improved model of how hydrogels work to their group based on the information obtained during reading/research. **Summative:** 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. Students complete journal entries documenting observations, data, discussions, and conclusions.	**Formative:** Facilitate ongoing questioning & discussion Promote discussion of diagrams/models and explanations. **Summative:** Evaluate group presentations Evaluate journal entries.

Teacher Notes: Hydrogels can be purchased cheaply as Jelly Marbles (www.SteveSpanglerScience.com) or Growing Spheres (www.teachersource.com). If possible, let students continue to grow the hydrogel marble overnight so they can observe how large they become. Encourage students to measure the marble in as many ways as possible. Provide materials such as a scale, ruler, thread, and compass to aid in their measurements. If possible, have students calculate changes in area of marble ($A = \pi r^2$) or volume of marble ($V = 4/3\pi r^3$) and discuss the importance of these quantities. If you plan on using the marbles again, use distilled water for the experiment.





Materials needed per group:

5 hydrogel marbles	Water
Clear plastic cup	Notebook
Spoon	Ruler and thread
Magnifying glass	Safety goggles

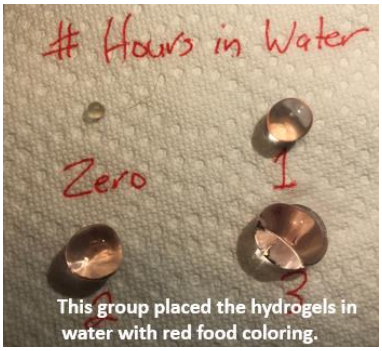
Part 2:

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?
Engage	• Students observe and measure their hydrogel marbles after they were placed in the water overnight. Students should measure their marbles in 1 or 2 quantifiable ways. • Students generate additional questions based on their final observations of the hydrogel marble.	• Encourage students to make careful final observations and measurements • Share and discuss questions that are generated
Explore	In this exploration, your job as a group is to create an experiment that will test how hydrogel marbles behave in an environment that is different than what you have observed in Part 1 of this lesson. Using what you have learned in your study of hydrogels, design a simple experiment where one variable (factor) is different from your previous experiment. It is a good idea to brainstorm different ideas before deciding on a factor that you think might be important. Once you decide on a variable, your group should develop a hypothesis that explains what you expect will happen during this experiment. **Criteria:** 1. Develop, discuss, and record your hypothesis. 2. Write your procedure and have it approved by your teacher. 3. Make sure to measure and record the changes that occur in at least 2 quantifiable (measureable) ways 4. Repeat the experiment a minimum of 3 times (with 3 marbles). **Constraints:** 1. Use only the materials provided and/or other materials approved by your teacher 2. Complete the challenge in the time allotted (one class period).	• Encourage students to make sure that their hypothesis is testable • Example: The warmer the temperature of the water, the faster the hydrogel marble will grow. • If appropriate, have students identify the I.V and the D.V. • Encourage students to make careful and detailed observations at each time interval • Ask/answer appropriate questions to guide student work as they develop their explanatory models.
Explain	• Students analyze their observations and data to explain whether their hypothesis was supported by the experimental evidence. • Students communicate their results to other groups and summarize what they have learned. • Other students ask questions and make suggestions.	• As needed, emphasize that the foundation of science is evidence-based explanation. • Stress the importance of having a testable hypothesis • Require students to use and display their data

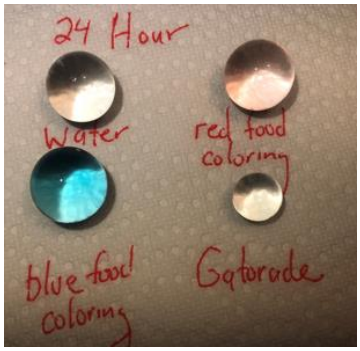
Elaborate	Students should think of another example where hydrogels could be used to solve a problem or create a new product. They should draw, label, and briefly explain how their idea could be used.	
Evaluate	**Formative:** Each group communicates their results to one other group and summarizes what they have learned. **Summative:** Each group communicates and presents their results the class and briefly summarizes what they have learned. Students complete journal entries documenting observations, data, discussions, and conclusions.	**Formative:** Facilitate ongoing questioning & discussion Promote discussion of diagrams/models and explanations. **Summative:** Evaluate group presentations Evaluate student journals

Teacher Notes:

Once again, encourage students to measure their marbles in as many ways as possible and calculate area and/or volume if possible. Provide similar materials as in Part 1 and additional materials such as food coloring, a variety of liquids, thermometers, and other available items that students request. Make sure to check student procedures to ensure their plans are safe and appropriate.



This group placed the hydrogels in water with red food coloring.



Materials needed:

Same as part 1 but also
Items requested by student groups
Lab notebook
Safety goggles
Phone/IPad for taking pictures (optional)

Safety Concerns:
Always wear appropriate protective gear while conducing science demonstrations.
Safety goggles should be worn for this experiment
Although hydrogel marbles are considered to be safe to handle, squeeze, and experiment with, you should never put chemicals (including the marbles) in your mouth, eyes, ear, or nose.