Title: How Wet Can a Diaper Get STEM Challenge

Estimated Time: 1-2 periods

Core Ideas (GSE Standard and elements):

S2P1. Obtain, evaluate, and communicate information about the properties of matter and changes that occur in objects.

a. Ask questions to describe and classify different objects according to their physical properties.

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.

a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures.

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.

Literacy Connections: Books	**Literacy Connections: Close Reads**
The Magnificent Thing, Ashley Spires All About Matter, Maui Schuh	Diapers Then and Now Close Read

Science and Engineering Practices:	**Crosscutting Concepts:**
Planning and Carrying Out Investigations: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Using Mathematics and Computational Thinking:** Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	**Scale, Proportion, and Quantity:** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Energy and Matter:** Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.

STEM Challenge

In this STEM Challenge, your task is to determine the volume of water a diaper can absorb before it becomes saturated. While this capacity is quite incredible and unlike any natural substance on the planet, it can be determined if you are careful and detailed in your measurement and calculations.

Ask	**Ask** your students if they how many disposable diapers a normal baby goes through before he/she is potty trained (3500). Ask them if they know what diapers were made of before disposable diapers became popular (mostly cloth). Ask them to brainstorm ideas that could explain why disposable diapers became so popular. What was it about them that made them so effective?
Imagine/Brainstorm	Ask **students** to brainstorm ideas that could explain why disposable diapers became so popular. What was it about them that made them so effective? Within the span of just a few years, cloth diapers virtually disappeared in many countries.
Plan/Design	In order to learn more about the topic, have them read (or read to them) the ***Diapers Then and Now*** article and discuss **Waterlock**, **molecule**, and **superabsorbers**. They can also brainstorm new ways that they think Waterlock could be used effectively. Next, have students **plan** and **design** how they will measure the volume of water that the diaper can absorb. They should also plan how they will determine when the diaper is saturated and no longer able to absorb water. Older students can also **plan** and **design** how they could measure the change in volume that occurs when the two substances are mixed together.
Create/Test	Students should **create** a model of a wet diaper by slowly adding water to their sample diaper. They should make **observations** and **record** what volume of water they add during each section. They should **test** the diaper to determine the total volume of water that it can absorb. Students should calculate the total volume of water absorbed by the diaper, record their data on the board, and compare it to other groups. If age appropriate, you can have your students use their observations and data to discuss whether or not they think the change within the diaper was a physical or chemical change.
Improve	After discussing and evaluating their results, students **improve** their method for testing the diaper. If time permits, let them re-test another diaper.

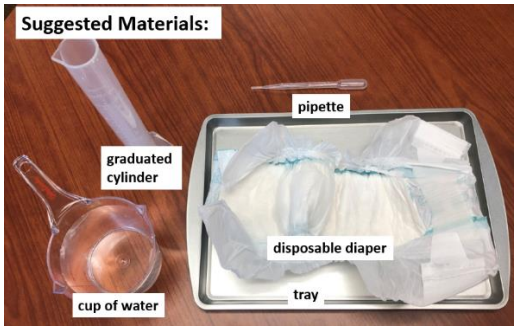
Teacher Notes:

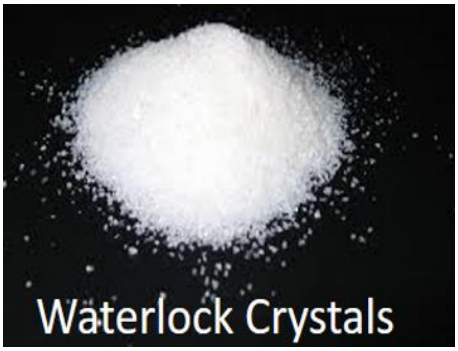
This is a super fun STEM Challenge where the results are hard to believe. The challenge is easy to set up and diapers are easy to obtain if you ask your students to help out and donate some. While safety googles aren't required for this activity, it is always a good idea to have kids wear them while doing experiments involving chemicals.

Waterlock can absorb an amazing 700 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 70,000 pounds of water from the pool. Because of this, it is called a **super absorber**. As it absorbs particles of water, it binds them up in gel form so that the water is no longer able to flow freely. Waterlock is often used in situations where water and other liquids are undesirable. Plumbers use it to soak up standing pools of water when the water pipes break in a house. Emergency rooms use it to bind up the liquid blood from injured patients that drips on tables and floors. Its most common use, however, is in disposable diapers. When babies urinate, the Waterlock absorbs the urine into the diaper and away from their skin. This

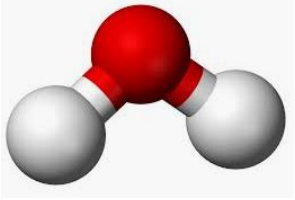
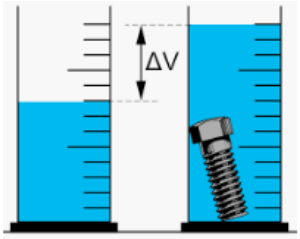
helps to keep their backsides dry and it even helps to prevent diaper rash. If you want results that more closely mirror those found with urine, add some salt to your water to obtain a 5% solution. This will reduce the amount of water that the diaper can absorb by about 80% (but still an impressive amount). You can also call it the Baby in the Pool STEM Challenge.

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. 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.





Vocabulary Cards:

chemical a pure substance consisting of matter 	**molecule** a group of atoms that bond together 
super absorber substance that absorbs 100's of times its weight in water 	**volume** amount of space a substance or object takes up 
saturate to soak completely with liquid 	**engineer** to design, build, and improve things 

Diaper STEM Challenge:

In this STEM Challenge, your task is to determine the volume of water a diaper can absorb before it becomes saturated. While this capacity is quite incredible and unlike any natural substance on the planet, it can be determined if you are careful and detailed in your measurement and calculations.

Procedure:

1. To learn more about diapers, read ***Diapers Then and Now*** article and discuss **Waterlock**, **molecule**, and **superabsorbers** as a class.

2. **Plan** and **design** how you will measure the volume of water that the diaper can absorb. You should also discuss how you will determine when the diaper is saturated and no longer able to absorb water.
3. **Create** a model of a wet diaper by slowly adding water to their sample diaper. Make **observations** and **record** what volume of water you add during each section.

4. **Test** the diaper to determine the total volume of water that it can absorb. Students should calculate the total volume of water absorbed by the diaper, record their data on the board, and compare it to other groups.

5. If age appropriate, use your observations and data to discuss whether you think the change within the diaper was a physical or chemical change.

6. Discuss 1-2 ways your could **improve** your method for testing the diaper to make it more precise. If time permits, re-test another diaper.

7. Using your knowledge of superabsorbent polymers, **explain** why the diaper was able to absorb so much water.