

Disappearing Water

Recommended Grade Level(s):

Appropriate for: All Grade Levels

Time Requirements:

Activity Time: 30 minutes

Teaching Topics & Concepts:

- To illustrate the absorbing power of the polymer found in diapers and other disposable hygiene products.
- Polymers, osmosis, diffusion, absorption, and atoms.
- Measurements, calculations, and observations.
- Structure and properties of matter; gels, solids, and liquids.



Background:

From cloth and pins to game-changing superabsorbent-polymers, disposable hygiene products have come a long way, baby! The advanced materials used in disposable absorbent hygiene products such as diapers and feminine pads have made life a lot easier for all of humanity. Feminine pads and baby/adult diapers share similar functions and materials. The absorption capacity of disposable absorbent products had significantly improved when manufacturers began using superabsorbent polymers (SAPs). Students can discover the science behind SAPs' ability to absorb up to 1,000 times their own weight in water in this activity.

Materials:

- Acrylic sodium salt polymer (A.S.A.P.), diaper powder, or potassium polyacrylate
- Styrofoam cup
- Bottle of water
- Piece of cardboard

Safety

- Read the S.D.S. sheets for acrylic sodium salt polymer.
- Adult supervision required when handling chemicals.
- Wear safety glasses and gloves.
- Water/powder may fall out of the cup.
- Do not ingest any of the materials used in the activity.
- Minimize inhalation of chemicals used. This activity should be done in a well-ventilated area.

Procedure:

1. Cover the bottom of a white Styrofoam cup with a thin layer of ASAP powder before class.
2. Show the class that the cup is empty by tilting it towards them. (The diaper powder is white and, as a result, cannot be seen.)
3. Pour a small amount of the bottled water (~10 mL) into the cup.
4. Glance in the cup to check if all the powder was wetted by water. If not, add some more water.
5. Place a piece of cardboard over the top of the cup and then invert the cup.
6. Place the cup over a student's head and then remove the cardboard.
7. Allow the student to look up and then reveal the empty cup to the class.

Disappearing Water (continued)

Expected Results:

The diaper powder turns to a damp white gel, which remains stuck to the bottom of the cup upon addition of water. Diaper powder absorbs ~900 times its own mass of water. It absorbs so well because it is a polymer which means its molecules are made of small, repeating units that form long chains. In its dry crystal form, sodium polyacrylate is coiled. When water is added, the long chains of sodium polyacrylate stretch out because each repeating unit in sodium polyacrylate contains an area that can support a negative charge. By adding water to the polymer, these areas form negatively charged ions that repel each other and cause the polymer to stretch out. As the polymer stretches, more water molecules can associate with its areas of negative charge. The unique shape of water also means it can associate with two polymer chains; two polymer chains surround each layer of water molecules. Each row of water molecules forms a bridge between the two chains. Water's ability to link between chains is called cross-linking, which allows the polymer to absorb a lot of water.

Follow up/Extension:

1. Students can try to release the trapped water from the polymer chain network by adding salt to the gel. Ions present in the salt displace the water molecules within the gel because they're more strongly attracted to the polymer than water.
2. Have students design a lab to determine the absorbing capacity of the powder and what conditions affect absorbance.
3. Fill a clear container with plain water and put some of the largest hydrated crystals into it. The crystals will appear to vanish! Students can learn how the concept of refraction helps explain their observation.

Questions for students:

1. Describe the process of diffusion when water and salt are introduced to the polymer?
2. How could the characteristics of superabsorbent polymers be useful in agriculture and retaining moisture in the soil?

Disposal/Clean-Up:

The cup and contents can be disposed of in the garbage.

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