Colorful Lather Printing

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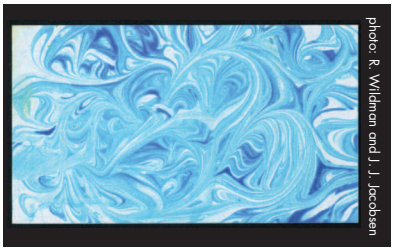
In this Activity, students marble paper with shaving cream and food color while exploring water, polarity, and hydrophilic and hydrophobic materials. Although the Activity is familiar, it contains a new twist—exploring how a colored shaving cream mixture behaves when a drop of water is added.



Paper marbled with shaving cream and food color.

Background

Soap is a topic rich in important concepts and familiar to students. Shaving cream contains a mixture of a liquid (soap dissolved in water), additional solid soap, and a propellant gas, which classifies it as a lather. A fatty acid like stearic acid and the base triethanolamine are often used to make the soap in shaving cream. The soap, triethanolammonium stearate, has a hydrophilic head composed of a carboxylate ion and triethaneammonium ion, and a hydrophobic tail made of a 17-carbon-long aliphatic chain from stearic acid.

Integrating the Activity into Your Curriculum

This Activity can be used to introduce the concepts of polarity, soaps, and surfactants. The composition of shaving cream lends itself to a discussion of types of phases, mixtures and, in particular, a discussion of foams as colloids. The careers of consumer product chemists *(1)* and the chemistry of other consumer products may also be relevant. Paper marbling is an ancient art, so the Activity can be effectively integrated with art or history lessons.

About the Activity

Activities that foster creativity as students learn chemistry concepts are popular among educators who believe that "fun, discovery, and creativity" should be part of the exploration of chemistry *(2)*. In this Activity, students first observe how food color spreads into water, paper, and shaving cream (which contains both polar and nonpolar components) and then observe the affinity that paper (cellulose) has for polar substances.

When a water drop is added to the surface of shaving cream tinted with food color, the color instantaneously disappears in the lather at the point of contact. The effect is similar to the demonstration where black pepper floating on the surface of water immediately spreads when soap or detergent contacts the water. Soaps and other surfactants are wetting agents. When a wetting agent dissolves in water, the surface tension of water is lowered. In this Activity, wetting occurs as the soap in the shaving cream dissolves in the drop of water that falls onto the tinted shaving cream. The surface tension of the added water drop is lowered, and the drop of water spreads. While one might guess that the water-soluble food color in the lather would diffuse into the added water drop, this is not immediately observed. Instead, dissolving and spreading of soap on the surface of the added water drop is observed and this causes the color to disappear at the water contact site. If the tinted foam and water drop sit undisturbed for 20–30 minutes, the diffusion of the food color into the white lather is clearly observed.

Foam pump soaps, having more water and alcohol, produce wetter papers with less distinct designs. Although less convenient than prepared food color, tempera and other water-based paints can be used. Shaving cream foam collapses quickly if oil-based paints are used.

Answers to Questions

1. The color diffuses completely and quickly into water and is absorbed by the paper. Due to the nonpolar tail of soap, the color spreads less in shaving cream.
2. The food color dissolves readily in water, and since water is polar, food color must be polar as well. Since the food color spreads into the paper easily, the paper must contain polar substances.
3. Paper primarily contains cellulose, which has polar hydroxyl groups at various locations, making it partially polar.
4. Mousses, whipped cream, some hand soaps, and carpet cleaners are similar examples of colloids.
5. Early artists would not have used the words hydrophilic, hydrophobic, polar or nonpolar to describe their materials, but since these artists might have prepared their materials from natural plants or colored rocks, they would still have acquired extensive knowledge of their materials and their interactions.

References, Additional Related Activities, and Demonstrations

1. Chemical careers in brief. *http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2%5C3wk%5Cwk3.html*
2. Sarquis, Jerry L.; Sarquis, Mickey; Williams, John P. *Teaching Chemistry with Toys: Activities for Grades K–9;* Terrific Science Press, Middletown, OH, 1995; pp 189–194 and pp 169–175.
3. Jacobsen Erica K. *J. Chem. Educ.* **2002,** *79,* 1162–1167 and references within.

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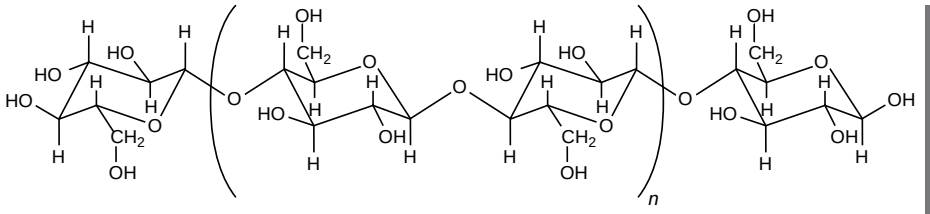
Paper marbling has been popular for centuries. In a Japanese version called *sumi nagashi* (meaning "ink-floating"), hydrophobic, carbon-based inks are dropped onto water and blown across the surface to produce swirls like those seen in polished marble. Rice paper lifts the ink off the surface of the water. In this Activity, you will investigate the art and science of the creation of colorful marbled paper patterns using shaving cream and food color. Shaving cream contains soap, which consists of long ionic species that have a hydrophilic ("water loving") head and a hydrophobic ("water hating") tail. Paper contains cellulose, which is a polymer of glucose (see below), as well as other chemical substances.



cellulose

photo by R. Wildman and J. J. Jacobsen

Shaving cream and food color prepared for marbling.

Try This

You will need: aerosol shaving cream (standard white type); paper plate; scraper such as spatula or tongue depressor; toothpicks; food color; 3–4 small (~3 × 5 in.) pieces of non-glossy, sturdy paper such as index cards, card stock, or art paper; eye dropper; water; small transparent cup; and paper towels.

Be Safe! Shaving cream can become irritating if left on skin for too long. Wash your hands when you are done.

__1. Read the label on a can of aerosol shaving cream. Record the list of ingredients.

__2. Place a drop of food color on a clean piece of non-glossy, sturdy paper, such as an index card. Observe and record how the drop spreads.

__3. Fill a small, transparent cup half-full with room-temperature water. Without stirring, add a drop of food color to the water. Observe and record how the drop spreads.

__4. Spray a pile of shaving cream the size of your fist onto a paper plate. Use a scraper such as a spatula or tongue depressor to shape the pile so that the top surface is flat and slightly larger than the paper that you will marble. Apply only 4–6 drops of food color to the shaving cream surface, one drop at a time. Observe and record how the drops spread.

__5. Drag a toothpick through the shaving cream and food color to create colored patterns. Press a 3 × 5 in. piece of non-glossy, sturdy paper firmly on the shaving cream surface. What do you observe through the back of the paper?

__6. Lift the paper off of the shaving cream. Scrape off any excess shaving cream close to the paper with a spatula or side of a tongue depressor and return it to the original pile. Observe the front of the paper. What happened?

__7. Repeat steps 5–6 to marble additional papers with the remaining tinted shaving cream, or move on to step 8.

__8. Using a spatula or tongue depressor, mix the leftover pile of colored shaving cream until it is one uniform color. If most of the color has already been removed by paper, add 1–5 more drops of food color before mixing completely.

__9. Using an eye dropper, apply a drop of water to the tinted shaving cream. Observe and record what happens.

More Things To Try

Try the same marbling technique using foam pump soap or gel shaving cream as the base, or different artists' paints on standard white shaving cream. What factors influence your results?

Questions

1. Compare and contrast the spreading you observed when dropping food color onto clean paper, into water, and onto shaving cream. Explain your observations.
2. Based on your observations, what claims can you make about the polarity of the food color and the paper? Explain.
3. Using the chemical structure of cellulose, explain the claims you made regarding the polarity of paper in question 2.
4. Shaving cream is a lather, similar to a foam. A foam is a colloid consisting of a gas dispersed within a liquid. (The liquid in shaving cream is water and soap, with larger sized soap particles dispersed in water.) What other common products are foam or lather colloids?
5. Artists have created beautiful marble papers since the middle ages. How do you think an artist's understanding of materials influences his or her work? Explain your answer.

Information from the World Wide Web *(accessed Jan 2007)*

Paper decorating. *http://www.cbbag.ca/BookArtsWeb/PaperDecorating.html*

Shaving cream—background, raw materials, the manufacturing. *http://www.madehow.com/Volume-1/Shaving-Cream.html*

Consumer product chemistry careers. *http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2\3wk\wk3_cpd.html*